Fall 2012

What Happens in Vegas: Addressing the Freshwater Crisis

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What Happens in Vegas

addressing the freshwater crisis

HANNAH MILLER | FALL 2012 THESIS PREP

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ABSTRACT

What Happens in Vegas: Addressing the Freshwater Crisis

There is a serious global freshwater crisis. Only 2.5% of the world's entire water supply is freshwater, and the majority of that small percentage is inaccessible for human use (i.e. trapped in glaciers, contained in soil as moisture, or too deep below the surface of the earth to access).[1] Studies of today declare more than thirty countries worldwide are experiencing chronic freshwater shortages. That number is expected to rise to a total of forty-five countries by the year 2025.[2] Freshwater availability and access is a major concern for today and will only be more-so as the global population continues to rise. According to the United Nation's, World Population to 2300, the world's population in 2050 is projected to have grown by 47% which yields an estimated 8.9 billion people worldwide.[3] Areas around the world are inevitably feeling these growth and demand strains, especially those facing serious drought conditions. Stretching from the Great Salt Lake in Utah to Southern California, the arid land of the Great Basin[4] is a prime example of this phenomenon.[5]

Las Vegas, one of the largest and most rapidly growing cities in the Great Basin region, has been significantly challenged to satisfy the growing water needs of the Valley. However, Vegas has fallen behind other western U.S. cities in addressing the freshwater crisis in that they have only implemented a small fraction of water-efficiency programs.[6] In an area that receives a mere 4.5 inches of precipitation annually, Las Vegans live a lifestyle that demands 30-50 inches.[7] As a result, Lake Mead (which supplies Las Vegas with 86% of their water), has seriously diminished dropping 100 feet in water level over the past ten years. Ultimately, Las Vegas needs a new water source. Otherwise, the city has begun "water grabbing"[8] throughout the region, pumping the limited water that supplies small agricultural communities and wildlife regions. Through an investigation of alternative energy sources and water systems as well as an intense study of the hydrology of the Las Vegas Valley region, the culmination of this thesis will propose a new alternative to supply the freshwater demands within the city of Las Vegas.

Research will ultimately begin with an intensive mapping exercise of Las Vegas and the surrounding region. Within Vegas, this mapping will study the breakdown of program within the urban fabric (i.e. residential, institutional, commercial, agricultural, etc.) and ultimately how much water each of these sectors demand. Simultaneously, a study of the surrounding region and the interrelationships between water demand and supply will ensue. Determining the primary and secondary sources of water in Nevada, how the water is transported and treated, who is receiving the water (industry vs. agriculture), and what happens to the culminating waste water are all investigations to be carefully examined and diagrammed. A third part to this initial stage of research will be a gathering of information on the history of water development in the Las Vegas/

Lake County area which will manifest itself in a graphic timeline through maps and diagrams explaining this advancement.

According to Jerry Yudelson, "water and energy are Siamese twins."[9] It takes energy to attain and supply water, but without water, there can be no energy production. This subsequent stage of research will explore alternative energy systems and their potentials to operate within the Vegas lifestyle. Case studies from around the globe will deem quite helpful, especially in Eastern Europe, Australia, and many of the desalination plants in the Middle East. Understanding key aspects of the climate of Las Vegas and potential energy to tap into is crucial for this stage of inquiry.

The final stage of research will ultimately entail a vigorous analysis of the typology of "The Vegas Strip." With the potential to become a fascinating site for intervention, understanding the forms, programs, and functions of buildings along the strip becomes crucial. A taxonomy of these elements will be made, as well as a 3D mapping diagram of the layers within the strip (buildings, transportation, green spaces, water systems, etc.). Understanding social issues, such as the role of residents vs. visitors, will add further depth to understanding the Strip, Vegas as a whole, and how it might create a new ecological relationship to the surrounding region.

The situation in Las Vegas is startling. The population has continued to grow without restraint in almost disregard of the ongoing drought diminishing the Colorado River and the lakes it supplies. The age old saying, "What happens in Vegas, stays in Vegas," has made its way into the attitude towards water consumption. There is a careless concern towards the limited supply of fresh water in the Great Basin region. Exploring new ways to provide water for this growing demand will not only help Vegas and the Southwest region of the States, but areas across the globe in similar drought situations might potentially benefit from this model.

Endnotes

1 David E. Lorey, Global Environmental Challenges of the Twenty-First Century: Resources, Consumption, and Sustainable Solutions (Wilmington: Rowman & Littlefield, 2003), 88.
2 Lorey, 89.
3 Department of Economic and Social Affairs (Population Division), World Population to 2300 (New York: United Nations, 2004), 4.
4 The Great Basin is North America's largest conglomeration of watersheds spanning over seven states. All water drains into the Colorado River
5 Great Basin Water Issues...
6 Las Vegas, Hidden Oasis
7 (47) Yudelson
8 "Water grabbing" = a phenomenon where cities send pipelines out side of city and tap into underground freshwater resources that supply agriculture and rural communities.
9 (53)

"By 2025, 1800 million people will be living in countries or regions with absolute water scarcity, and two-thirds of the world population could be under stress conditions."

-UN Water statistics

CHAPTER 1

GLOBAL CRISIS

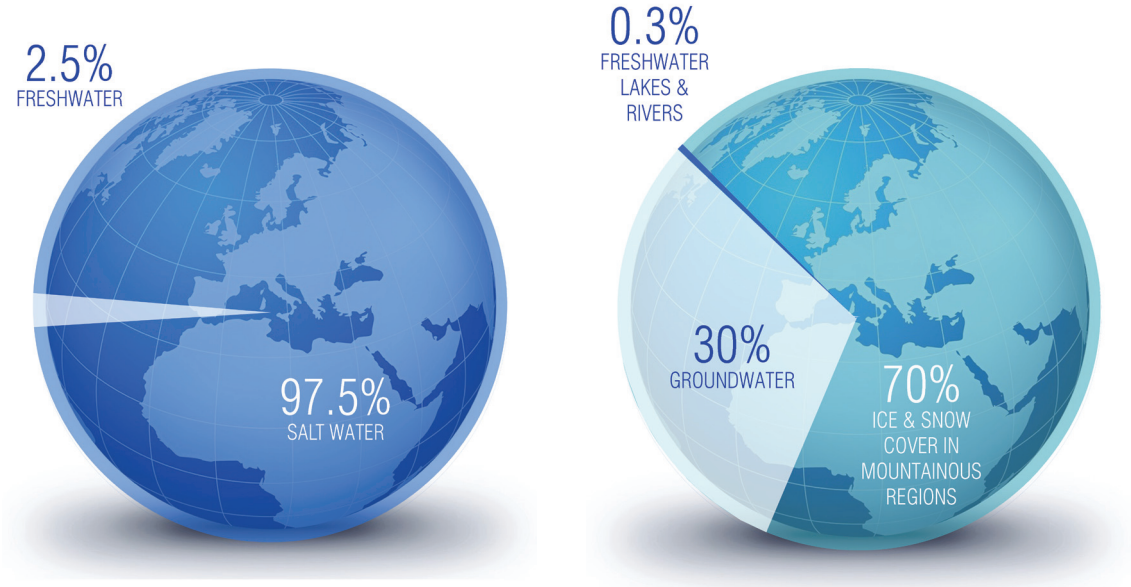


Figure 1.1
Charts explaining the portioning of freshwater throughout the globe. Out of the 2.5% freshwater on the planet, we can only access about one third of that quantity.

FRESHWATER on the PLANET

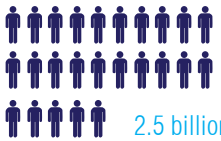
Over the last half of a century, the global demand for water has tripled. With the increase in drought, population, and governments' failure to limit the pumping of aquifers, the world has begun to incur a vast and scary water-deficit. The problem is most do not recognize this largely invisible catastrophe slowly emerging on the horizon.[1]

The total amount of water on the planet remains at a constant total; it is a renewable source. Water cycles through our atmosphere by evaporating from the surface of the ocean and then falls as rainwater over the land that we inhabit. More water cannot be added to this cycle, and it is impossible to lessen the total amount as well. However, only a tiny percentage of that water is available to us as usable freshwater. No new freshwater supply has been created since the beginning of recorded time. As we "mine" ground water supplies, divert rivers and streams for agriculture, and draw water from lakes and reservoirs faster than they can refill, once the water is gone, it is gone.[2]

POPULATION on the PLANET

water shortages

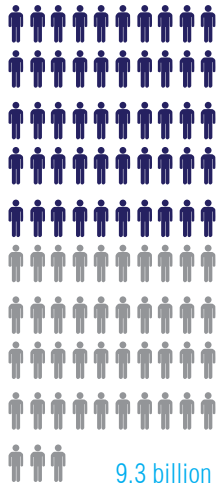
According to the United Nations "World Population to 2300" report, 40% of the world's population will be experiencing freshwater shortage. Upon studying fertility trends and demographic growth, the UN predicts in the next two centuries the global population will have reached over 36 BILLION people. Planet earth simply cannot feed and supply the needs of that many people.[3]



2.5 billion

1950

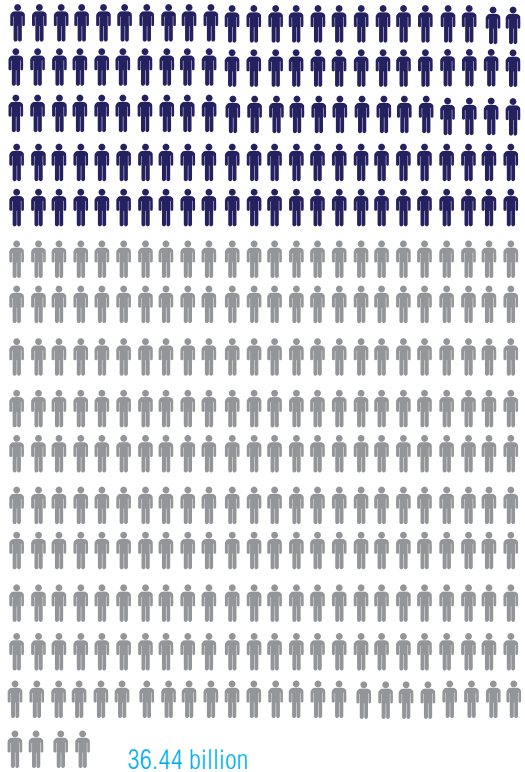
World population mid-20th century



9.3 billion

2050

40% of the total world population by 2030 will experience water shortage

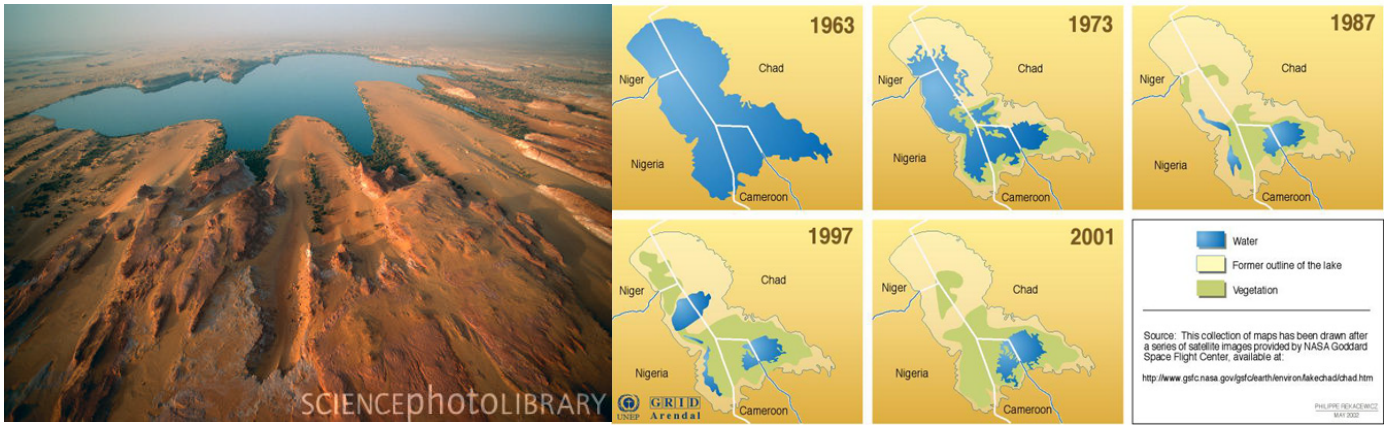


36.44 billion

2300

Who knows how many by then?

LAKE CHAD
disappearing



AGRICULTURAL DIVERSION / IRRIGATION

DROUGHT

DAMS / DIVERSIONS

POPULATION INCREASE

CLIMATE CHANGE

OVERGRAZING

Lake Chad is located at the intersection of four countries in West Africa: Chad, Niger, Nigeria, and Cameroon. Once one of Africa's largest bodies of fresh water, the lake has severely diminished in size over the past half a century. This is largely due to intense drought, human demand, and diversion of the lake for irrigation purposes. "Lake Chad is now a ghost of its former self," reports NASA after studying the disappearing lake via satellite.[4] It is feared that Lake Chad might cease to exist as we know it by 2030.

YELLOW RIVER
disappearing

AGRICULTURAL DIVERSION / IRRIGATION

DROUGHT

DAMS / DIVERSIONS

POPULATION INCREASE

CLIMATE CHANGE

OVERGRAZING

The Yellow River, once a seemingly limitless supply of water, is disappearing fast. One of the biggest factors has been due to the proliferation of factories, farms, and cities all working together to accelerate the Chinese economy. All the products leaving China must give credit to their source: the Yellow River. Diversion for irrigation and increased population growth has severely diminished the water's supply. Industry now pollutes the remaining waters with toxins and chemicals from unregulated dumping. In its race to become the world's next superpower, China is draining all her resources, both rivers and aquifers, and polluting what is left of the "Nile of China." The Yellow River, an enduring symbol of glory and mystical force of nature, is disappearing fast, and it might be too late to save it.[5]

ARAL SEA

disappearing

AGRICULTURAL DIVERSION / IRRIGATION

DROUGHT

DAMS / DIVERSIONS

POPULATION INCREASE

CLIMATE CHANGE

OVERGRAZING

The Aral Sea, located in Central Asia, is soon to disappear completely. Once the fourth largest lake on the planet (1960), since then it has lost 90% of its original volume. Evaporation caused by drought and wasteful irrigation have demanded too much of this water source. The sea's shorelines once were filled with thriving fishing villages; now, there remains a graveyard-like expanse, desperately longing to replenish its now barren land. This incredible devastation is acknowledged by many environmental experts as one of the world's greatest manmade ecological disasters.[6]

COLORADO RIVER
disappearing

AGRICULTURAL DIVERSION / IRRIGATION

DROUGHT

DAMS / DIVERSIONS

POPULATION INCREASE

CLIMATE CHANGE

OVERGRAZING

The Colorado River flows through seven US states and into Mexico, supplying 30 million people with water. Big cities such as Denver, Las Vegas, Phoenix, Tucson, Los Angeles, and San Diego all depend on the river. The Colorado also irrigates 4 million acres of desert-turned-farmland. Infrastructural elements, such as dams, reservoirs, pipelines, and aqueducts, alter the river's flow. As the water levels drop drastically, researchers predict the Southwest will soon descend into Dust Bowl conditions mid-century. Serious shortages and potential water wars, emerge on the near horizon.[7]

The Colorado River has a one in two chance of drying up completely by 2050....but

why?

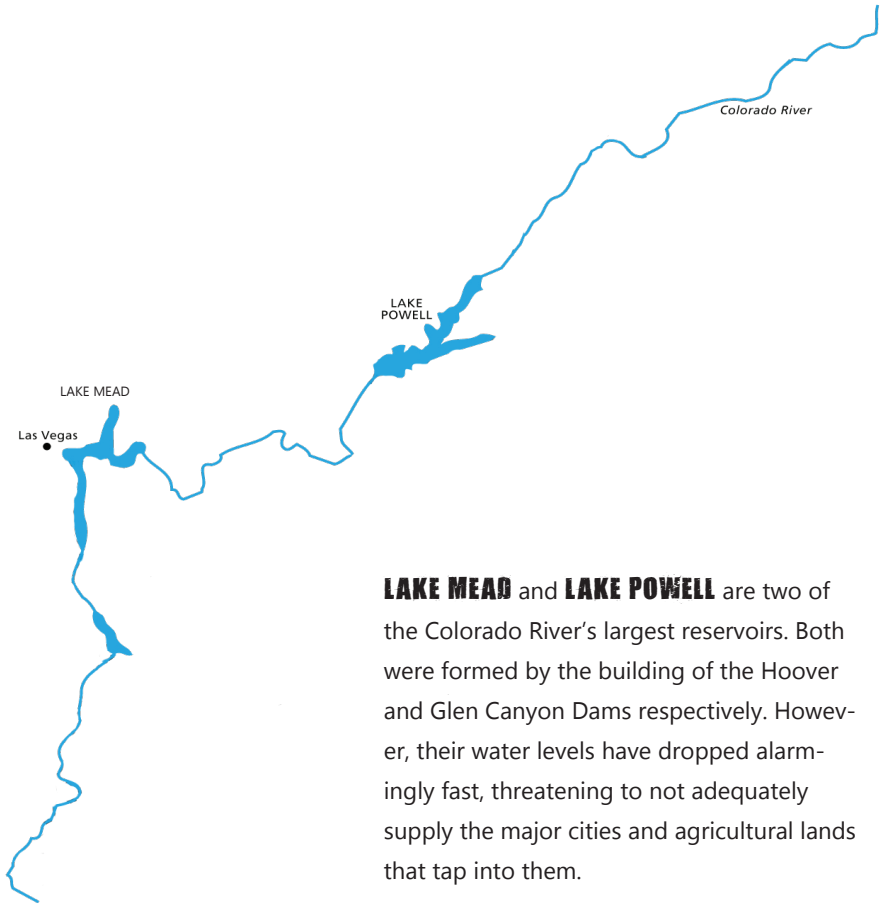
"Lake Meade," Brian L. Frank, Global Post, Photo Story: Death of the Colorado River, October 7, 2010, <http://www.globalpost.com/dispatch/the-americas/101007/death-the-colorado-river>.

CHAPTER 2

COLORADO RIVER BASIN

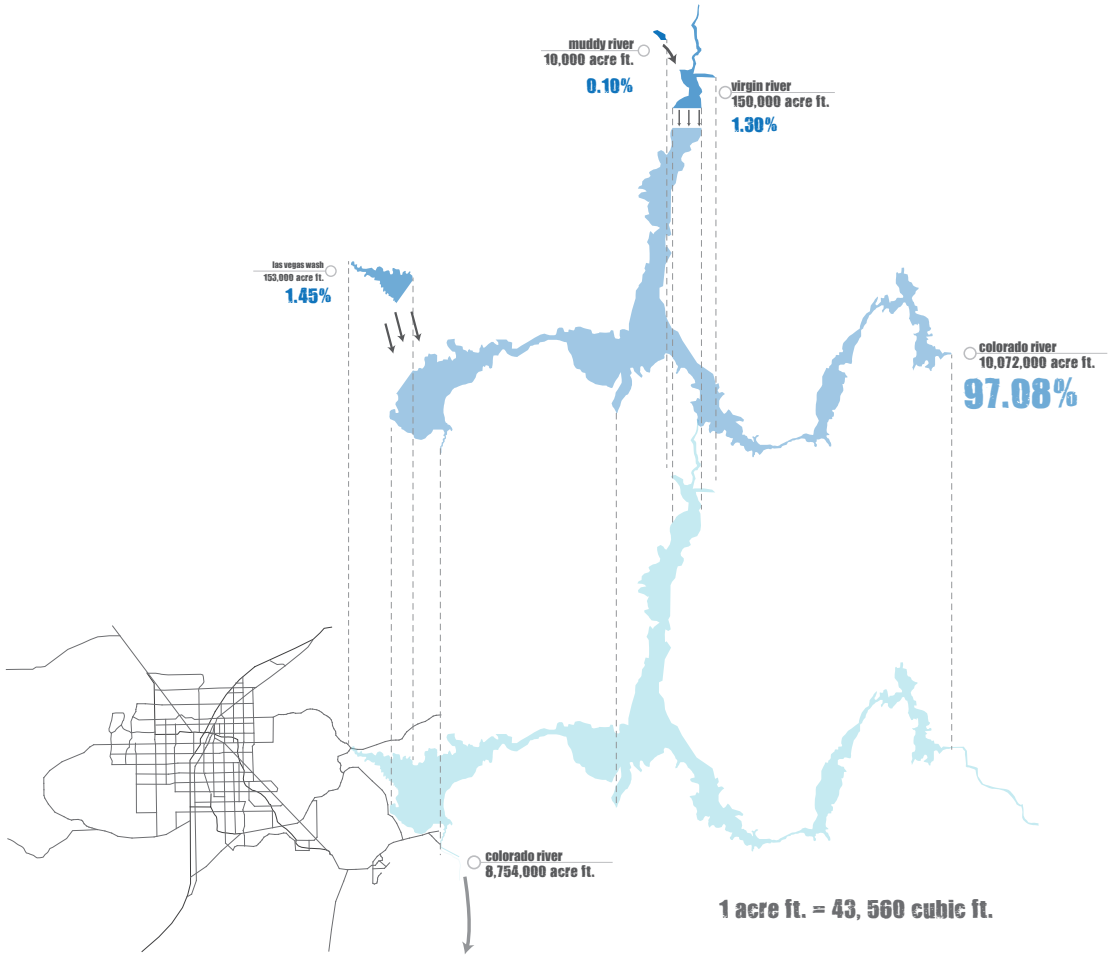
Colorado River Basin

The Colorado River Basin supplies 30 million people and thousands of acres of farmland. It is the largest watershed in North America, spanning seven states. In 1922, the river averaged 17.5 million acre-feet (5.7 trillion gallons) of water. Now, the river averages 14.7 million acre-feet per year and is rapidly decreasing in that amount. Over-allocation, rapidly increasing urban populations, conflicts of unused water rights, and severe drought are some of the major reasons why the Colorado River Basin is in such distress.[1]

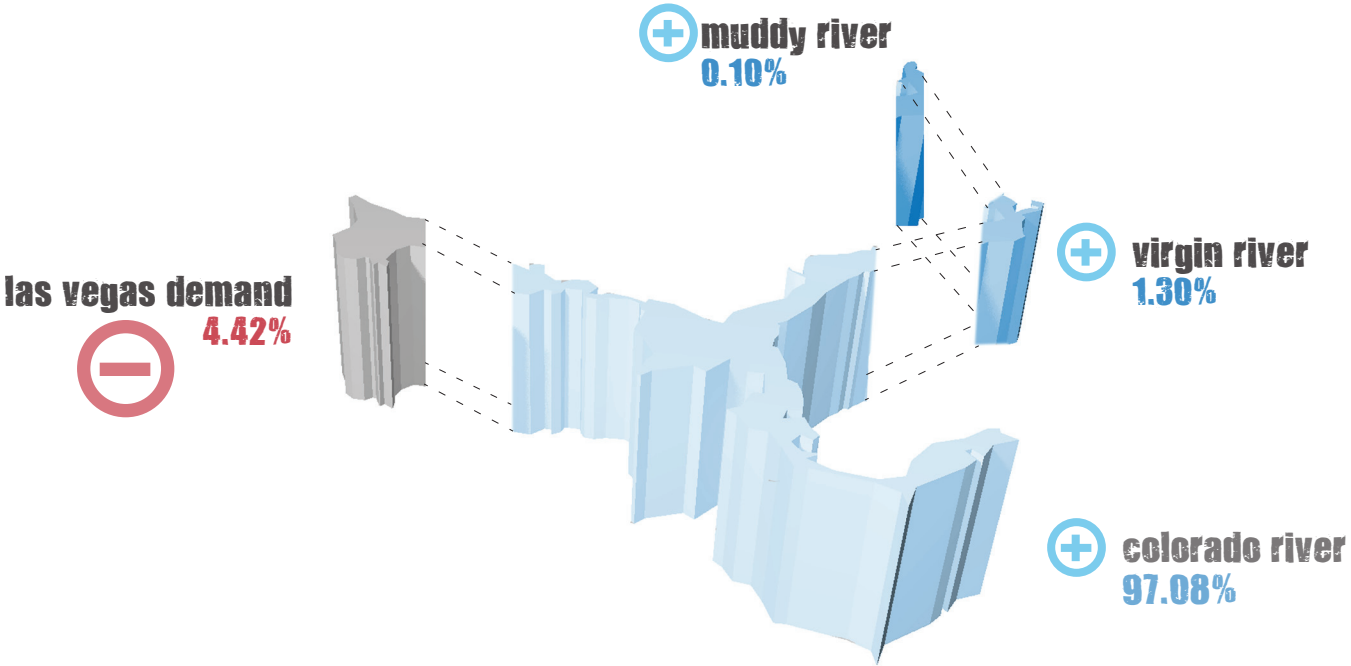


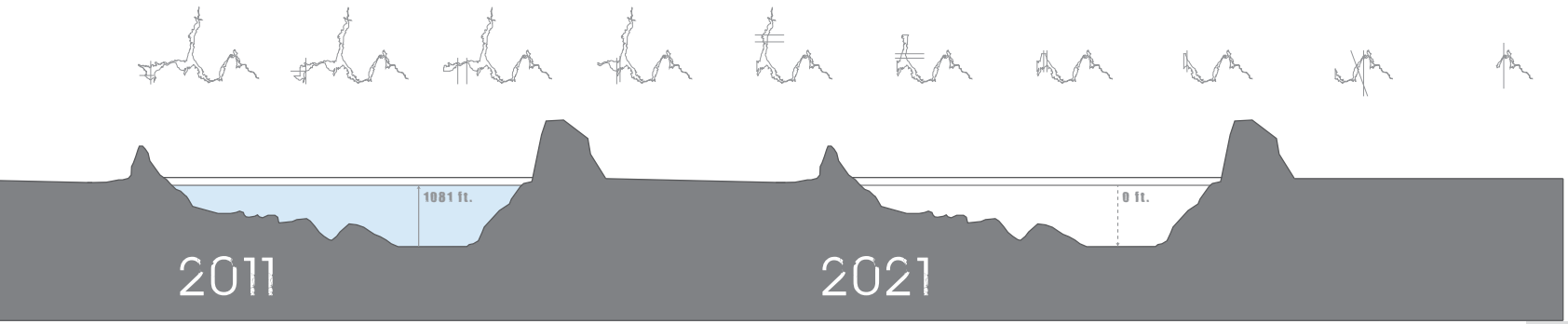
LAKE MEAD and **LAKE POWELL** are two of the Colorado River's largest reservoirs. Both were formed by the building of the Hoover and Glen Canyon Dams respectively. However, their water levels have dropped alarmingly fast, threatening to not adequately supply the major cities and agricultural lands that tap into them.

Lake Mead

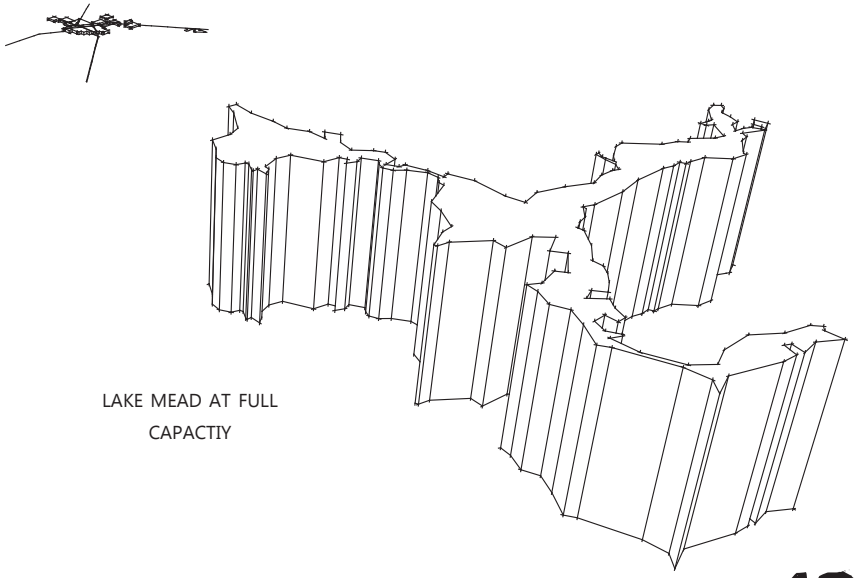

muddy river
10,000 acre ft.
0.10%
virgin river
150,000 acre ft.
1.30%
las vegas wash
153,000 acre ft.
1.45%
colorado river
10,072,000 acre ft.
97.08%
colorado river
8,754,000 acre ft.
1 acre ft. = 43, 560 cubic ft.


LAKE MEAD
water levels
1226 ft.
1983
1216 ft.
2000


muddy river
0.10%
las vegas demand
4.42%
virgin river
1.30%
colorado river
97.08%

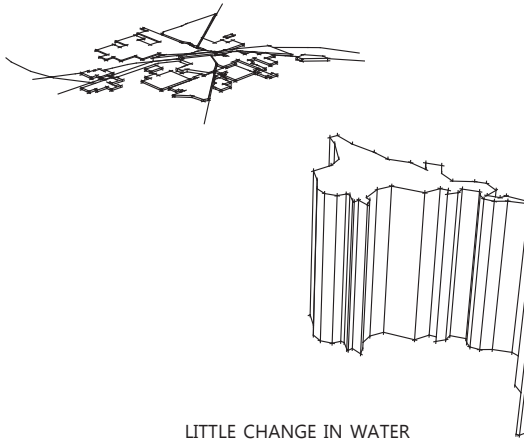

1081 ft.
0 ft.
2011
2021

Lake Mead | SHRINKING



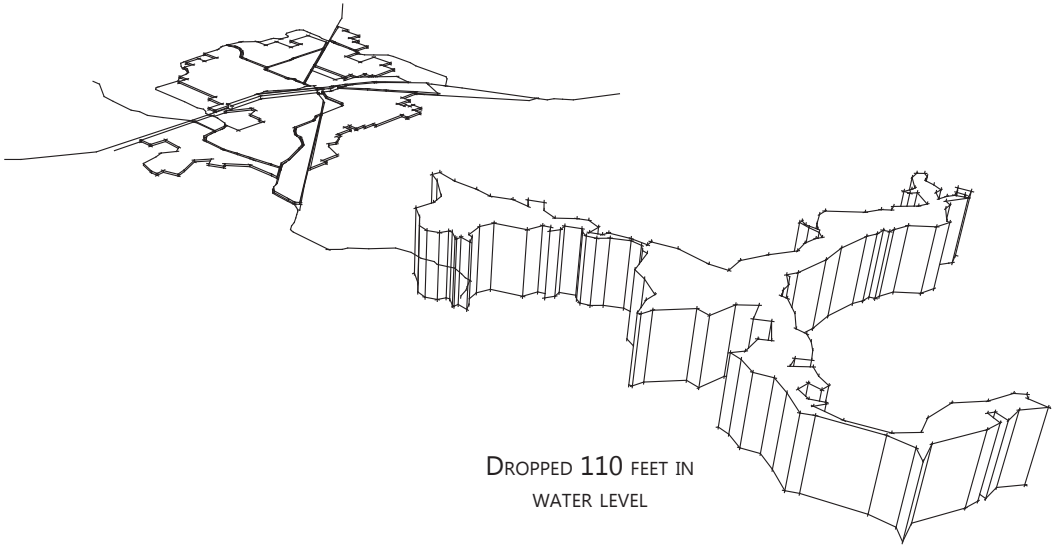
LAKE MEAD AT FULL
CAPACTIY

1950



LITTLE CHANGE IN WATER
LEVEL EXCEPT MINOR
DROUGHT

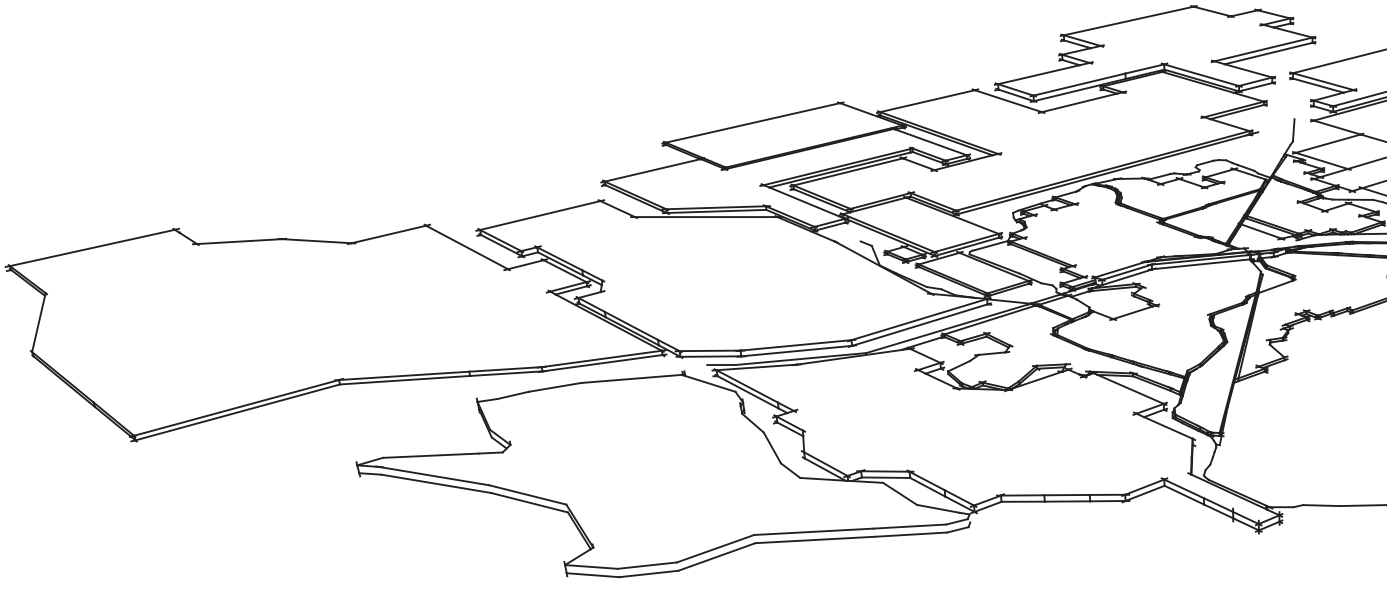
1980



DROPPED 110 FEET IN WATER LEVEL

2012

Lake Mead | GONE



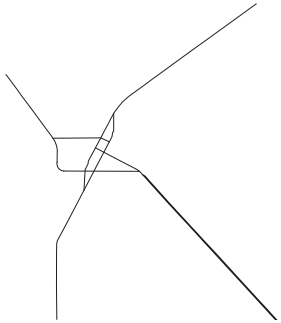
VEGAS CONTINUES TO GROW AND SPRAWL, DEMANDING FAR TOO MUCH OF THE LAKE MEAD WATER SYSTEM. IT WILL EVENTUALLY HAVE GONE TOO FAR.

2012 & beyond...

CHAPTER 3

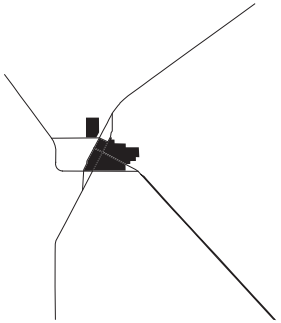
WHAT HAPPENS IN VEGAS

LAS VEGAS Over the Years



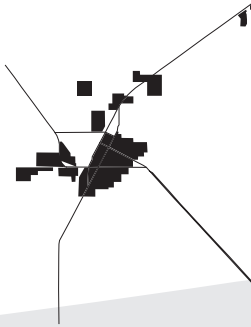
Early 1900s

Vegas as a small railroad town



1931

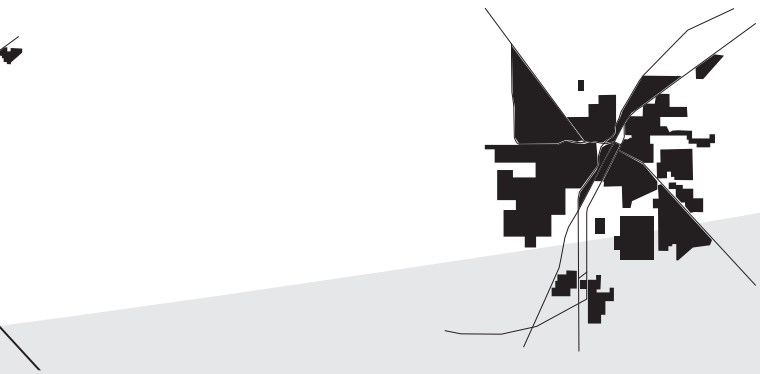
Hoover Dam was constructed/commissioned by President Roosevelt.



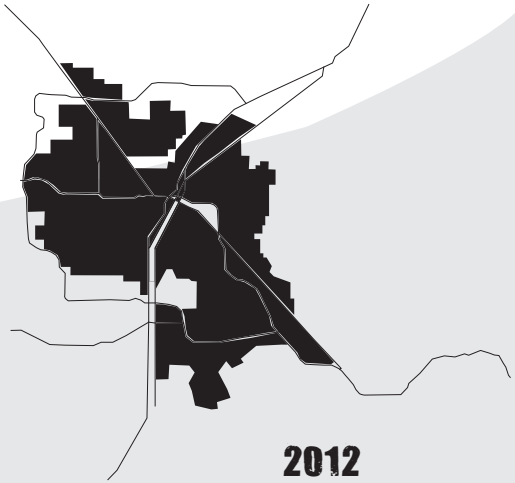
1940s & WWII

Cheap energy, seemingly endless watersupply, and vast desert land, the government set up a military base for testings during WWII.

Figure credits still to be added



1960s casino *BOOM*

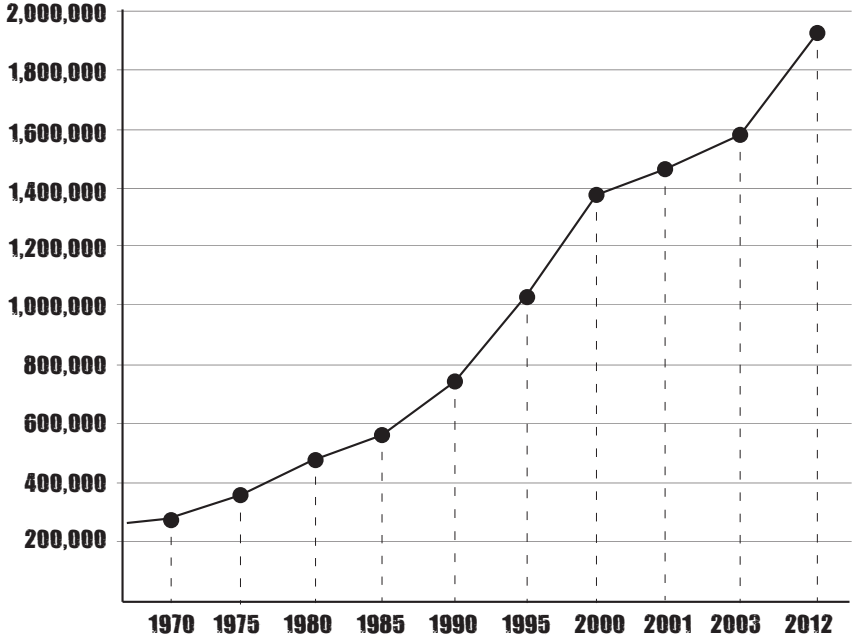


2012

The casino boom in the 1960s began to draw many people west to visit and settle Las Vegas.

Modern day Vegas is booming like no other...well on it's way in becoming another U.S. megacity.

LAS VEGAS TODAY



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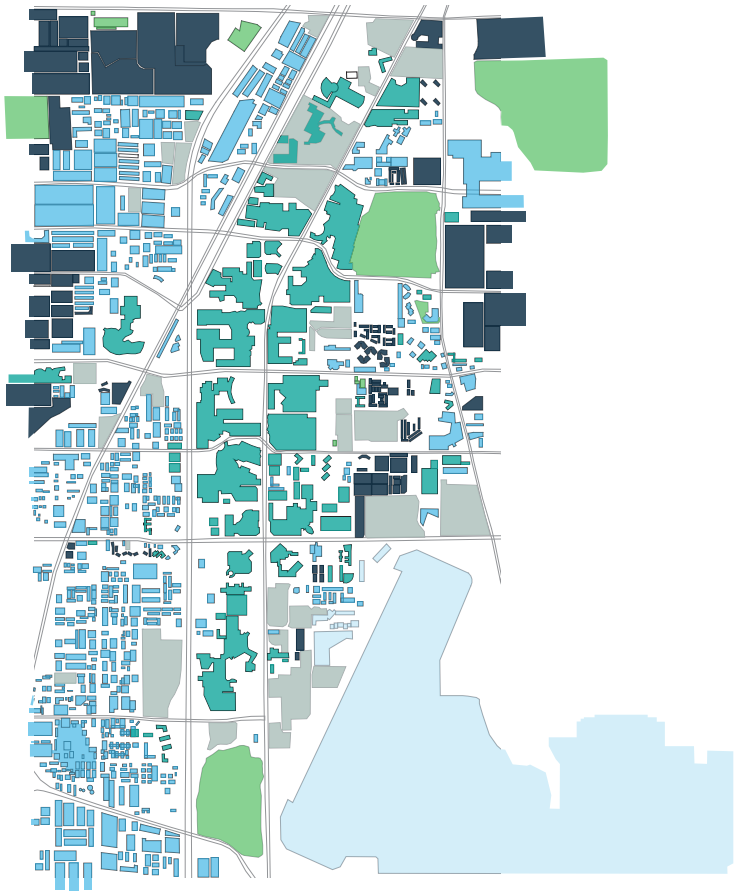
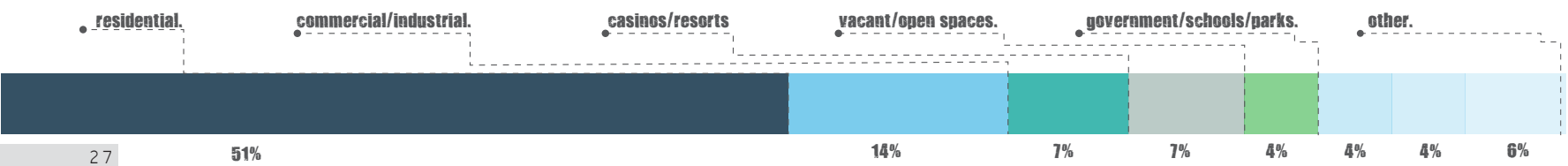
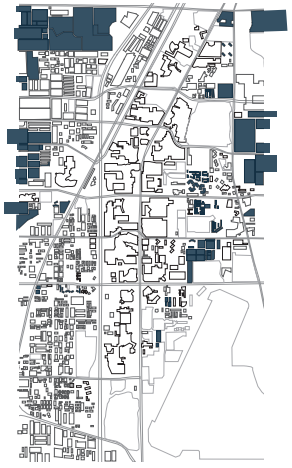
http://www.greatlasvegashomes.com/images/las-vegas-luxury-homes_400.jpg

http://www.desertpinesgolfclub.com/content/slides/desert-pines-las-vegas-strip3.jpg

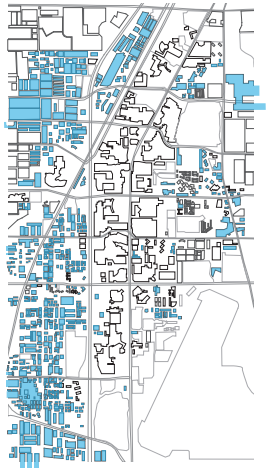
Water Usage in Las Vegas



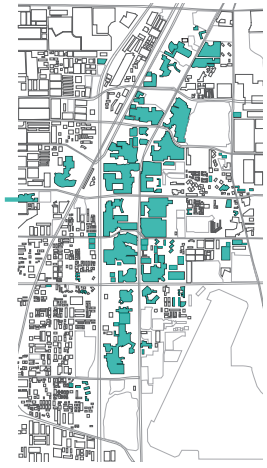




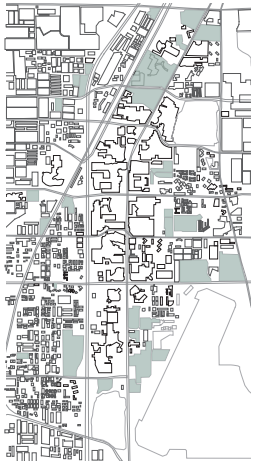
RESIDENTIAL 51%



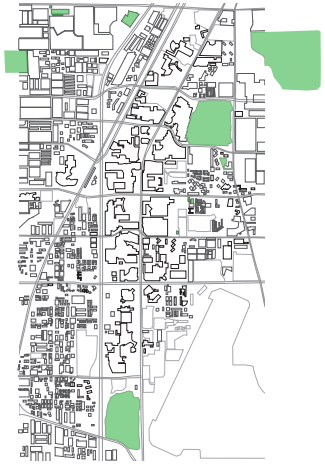
COMMERCIAL/INDUSTRIAL 14%



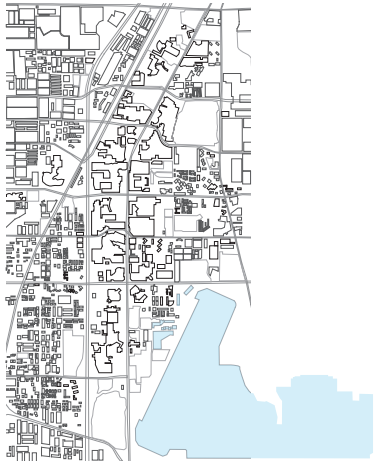
CASINOS/RESORTS 7%



VACANT/OPEN SPACES 7%



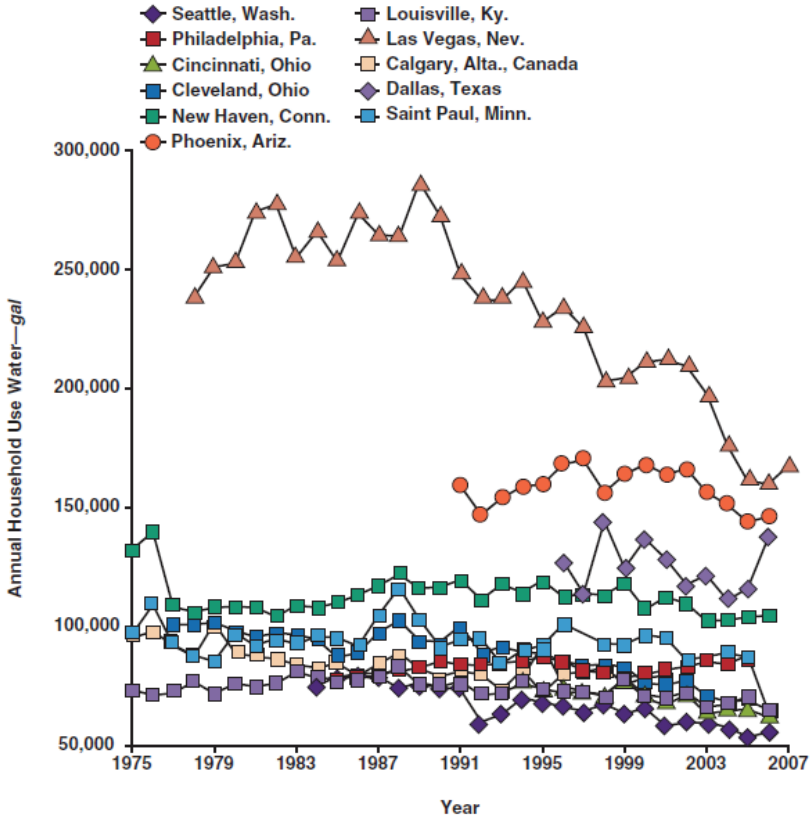
GOV./SCHOOLS/PARKS 4%



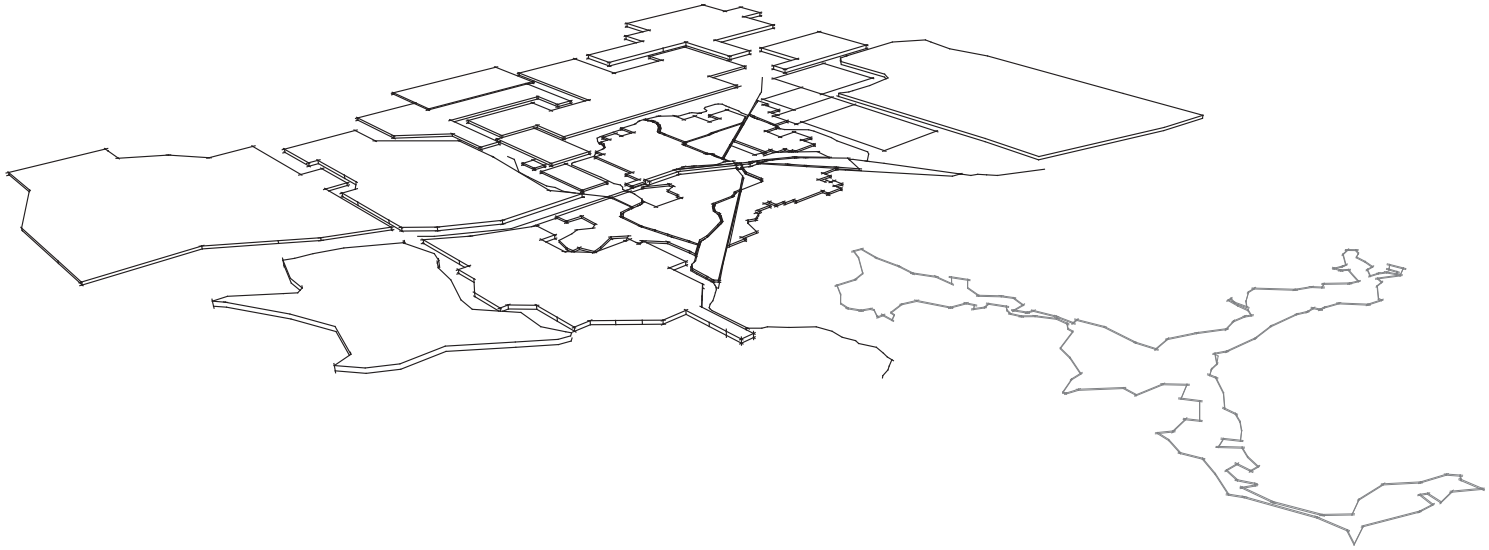
OTHER 14%

Water Trends & Policies

FIGURE 1 Overview of 11 regional partner utilities' water use



Source: Coomes, P., T. Rockaway, J. Rivard, and B. Kornstein. North American Water Usage Trends Since 1992. *©2010 Water Research Foundation. Reprinted with permission.*



Vegas needs a new source of water

The Temporary Solution: Water grabbing

..drawing down water tables destroying a century-in-the-making of farmer and rancher communities,

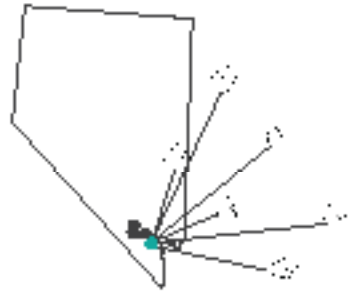
..killing thousands of acres of deep rooted shrub and wetland plant communities leading to "dust bowl" conditions,

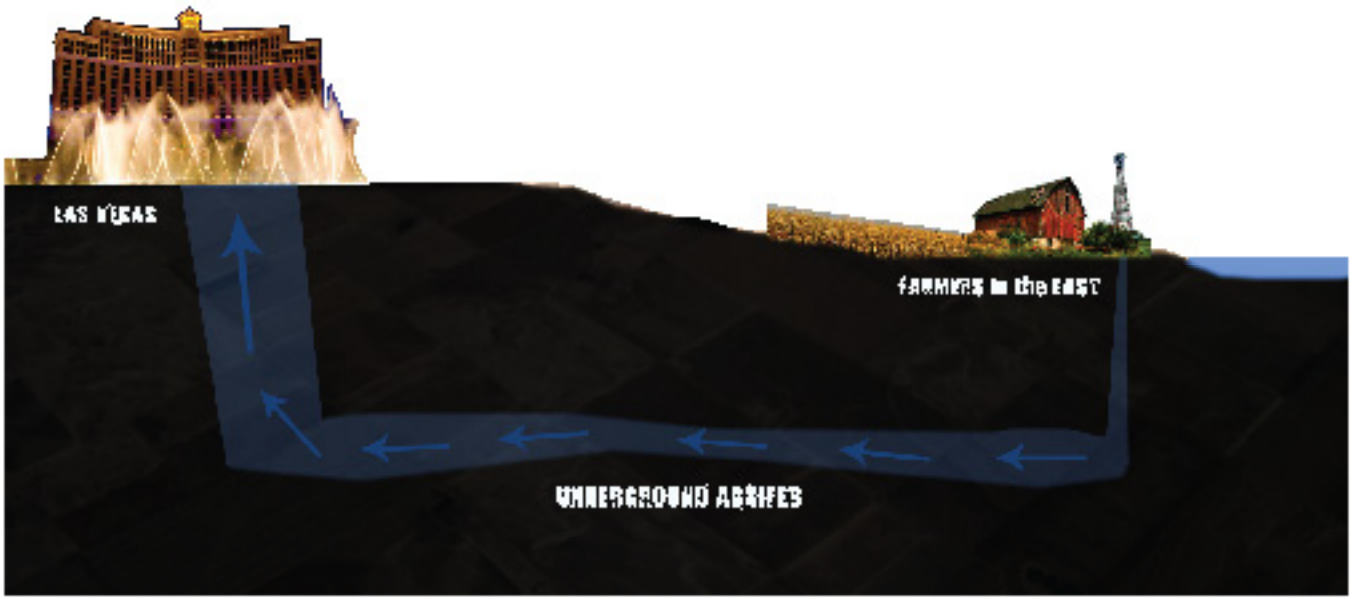
..damaging or destroying regional springs and wetlands which support rural communities and wildlife,

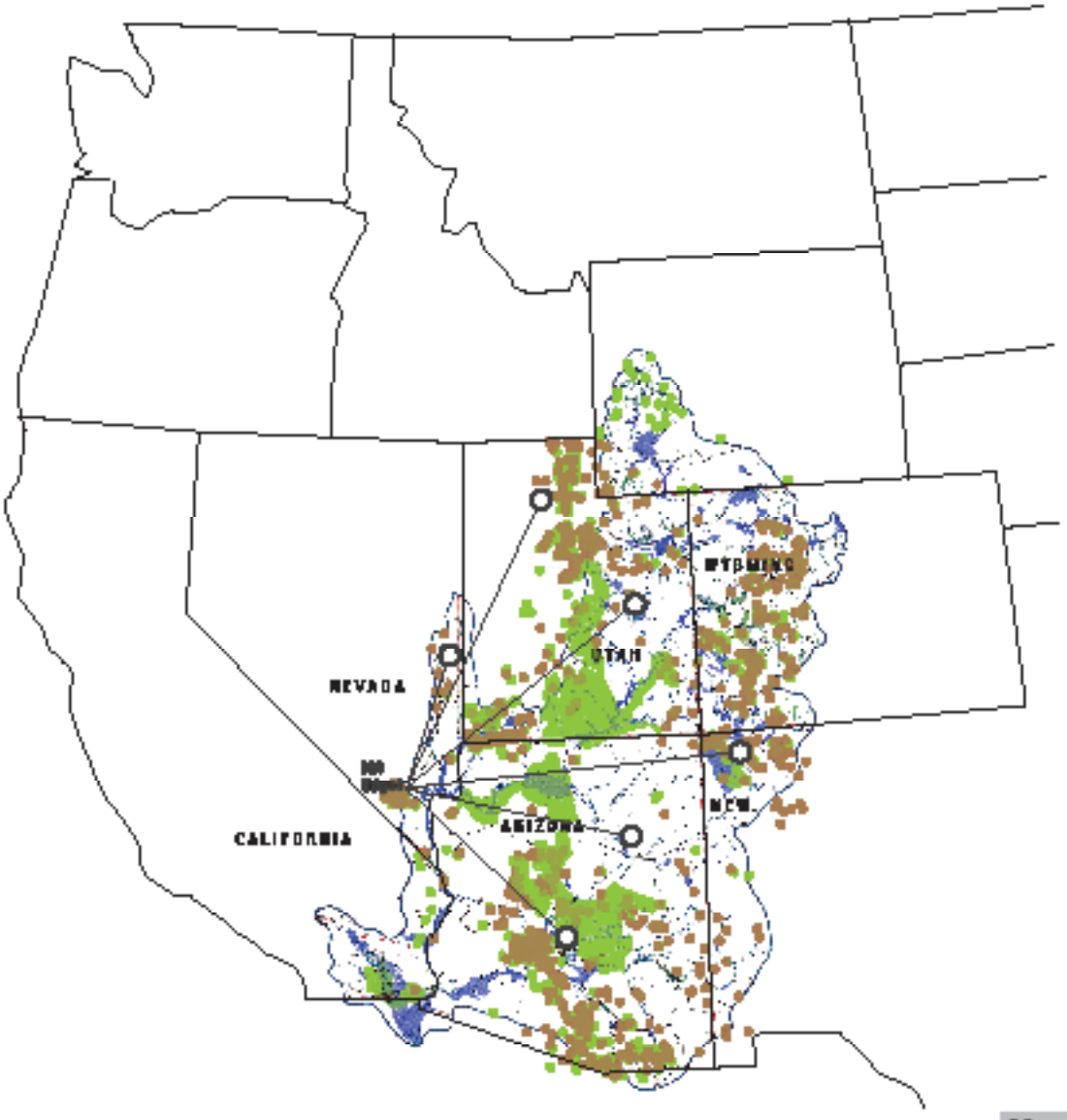
..harming Nevada, Utah and California National Parks, National Wildlife Refuges, State Parks, and State Wildlife Areas by lowering groundwater and diminishing (even extinguishing forever) springs, wetlands, and creeks within and adjacent to these protected areas,

..damaging or destroying rural livelihoods and economies,

$8.5 billion for 300+ miles of piping

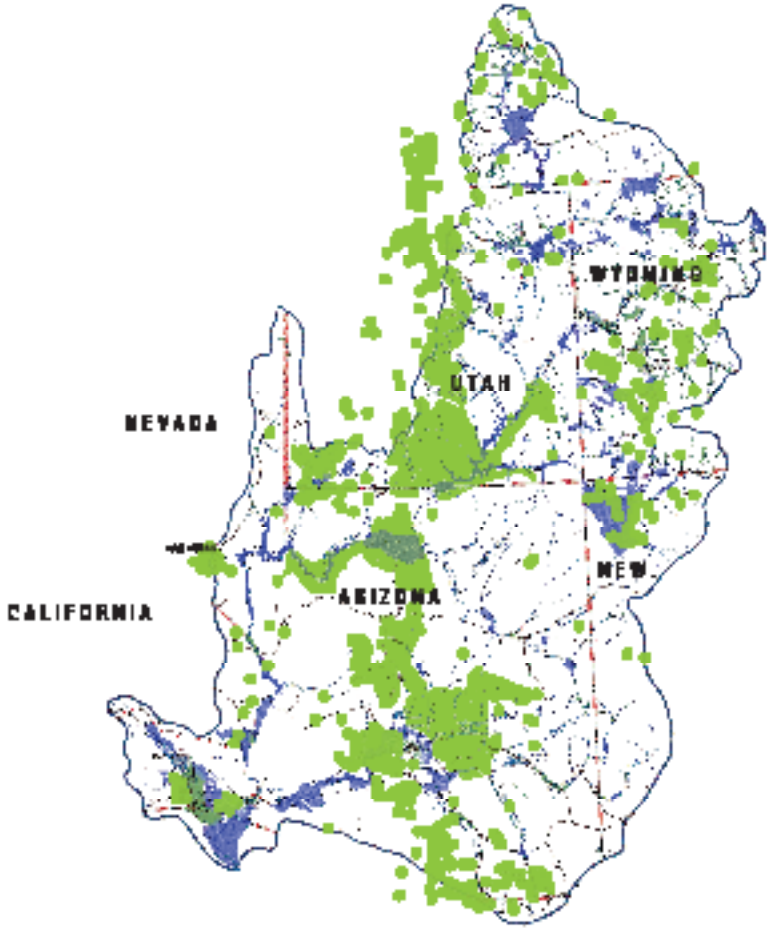




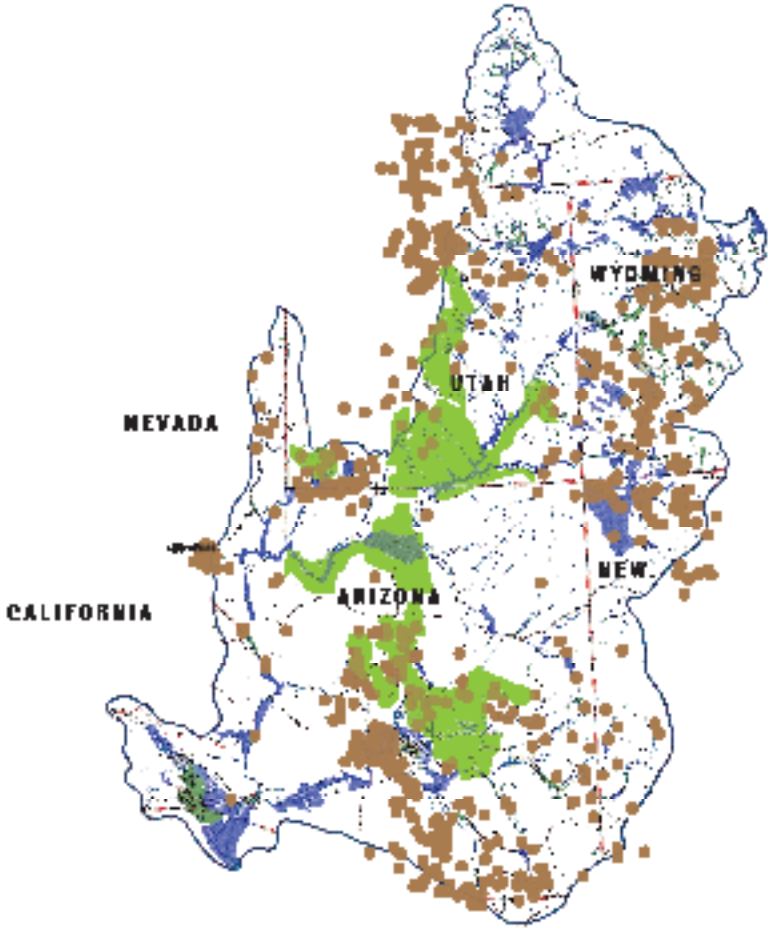


LEGEND

- NATIONAL PARK/PRESERVE/FOREST
- RANCH
- FARM
- WATER RESOURCE



FARMS IN DANGER OF WATER GRABBING



RANCHES IN DANGER OF WATER GRABBING

Vegas needs a new source of

"inexhaustable"

WATER.

NEW Longterm Solution

"Pipe to the Ocean"

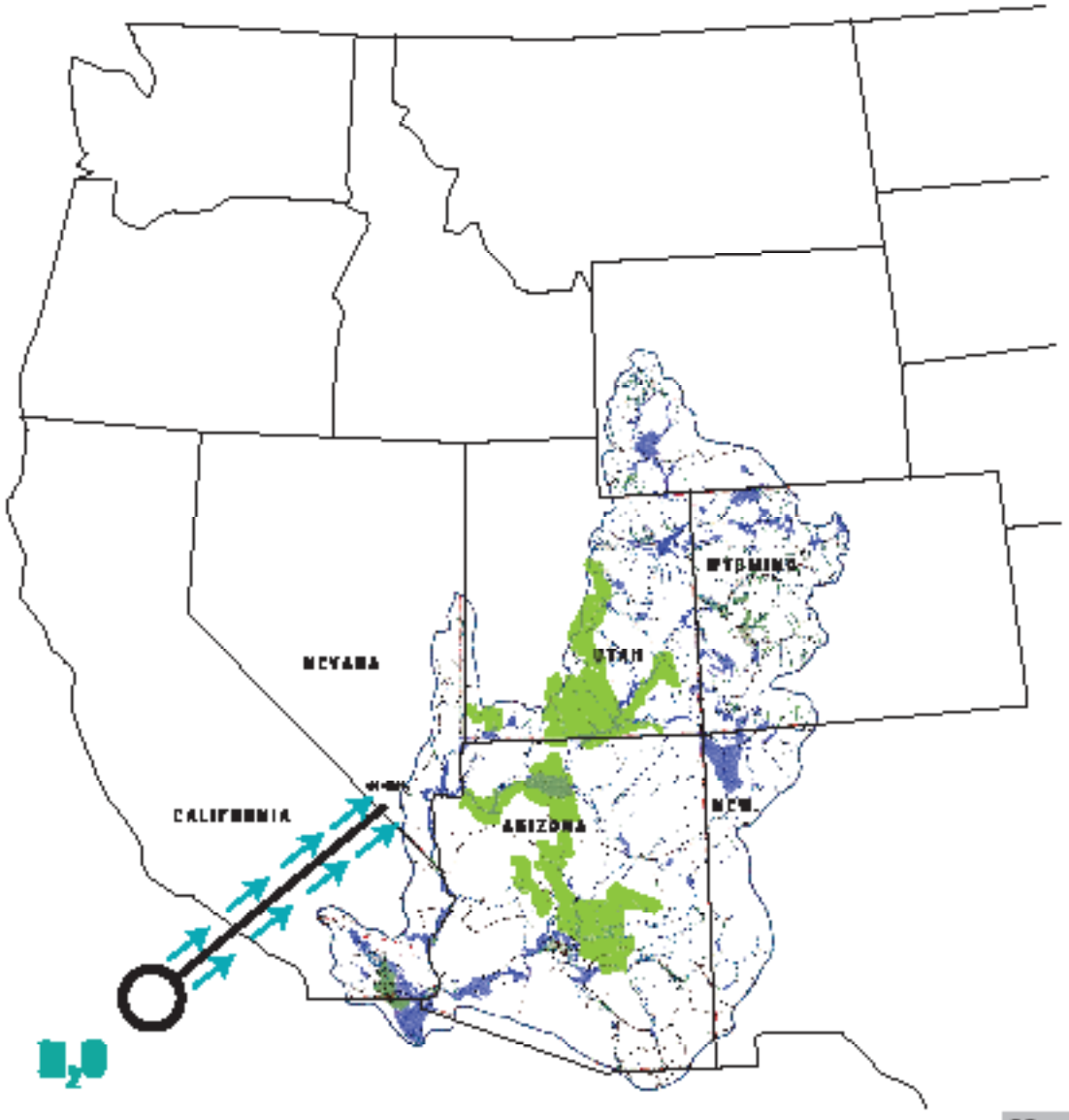
Las Vegas needs a new source of water. But sending pipelines farther inland will only deplete the little remaining water in the Colorado River Basin supplying farmers and smaller towns.

This project proposes sending the same amount of pipeline out to the ocean to tap into the world's inexhaustible water source.

Desalination Plant

The implementation of a desalination plant along the coast of Southern California will supply new, freshwater to the city of Las Vegas. Any surplus will be sent back into the Colorado River Basin system, helping the drought conditions.

However, this new freshwater needs a way to be transported from the coastal plant to the city of Las Vegas. This project proposes to design a new "H2O corridor," a monumental piping system that brings new water to thirsty Las Vegas Valley.



"Desalination is not a cheap way to get water, but sometimes it's the only way there is."

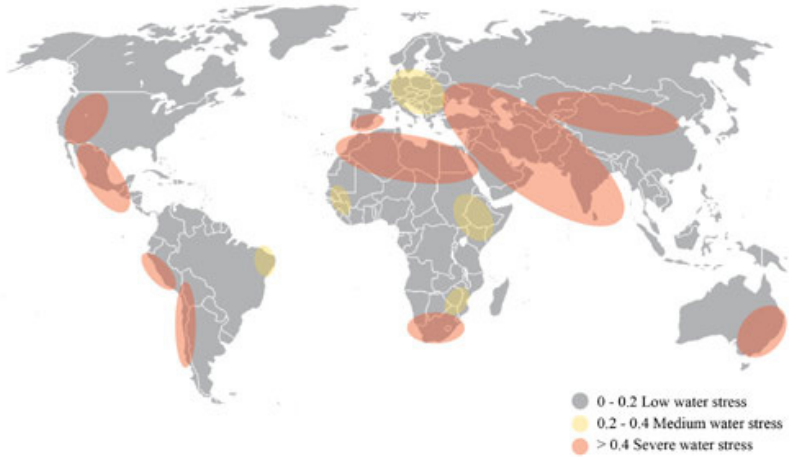
- Tom Pankratz,
editor of the Water Desalination Report

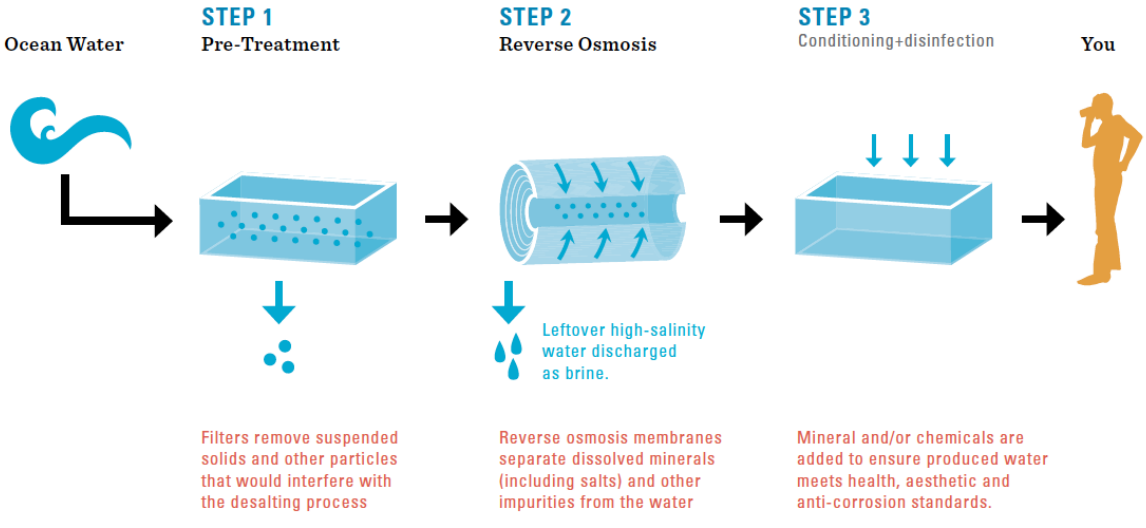
CHAPTER 4

THE ANSWER: DESALINATION

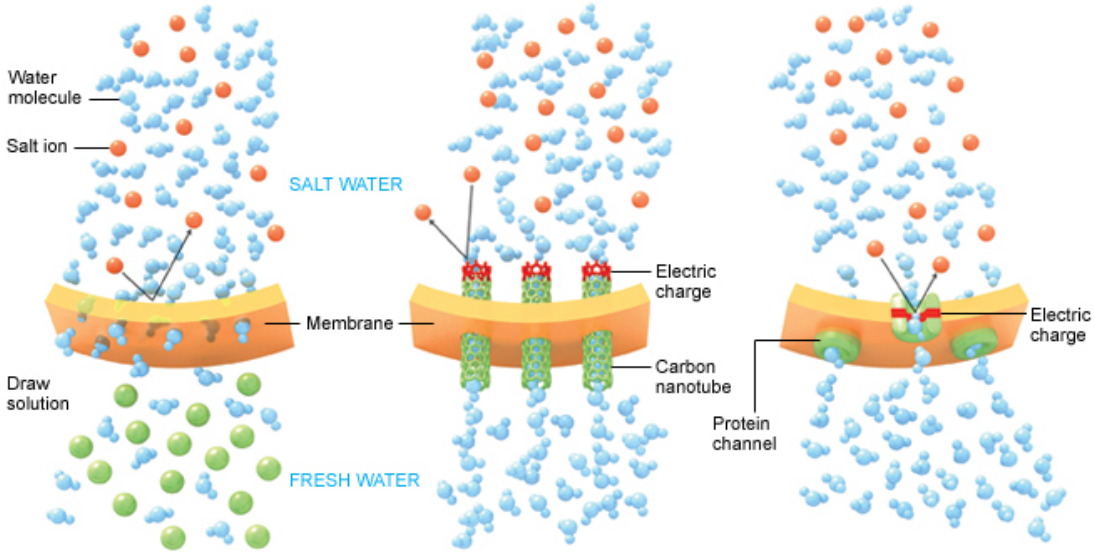
How it works: The Big Idea

The exploration into the changing composition of salt water to a drinkable counterpart began in the mid-1900s. It wasn't until the 1970s when desalination really began to take off in the Middle East as a means to acquire more freshwater. Today, there are desalination plants in 150 different countries. Approximately 21,000 desalination plants line the coasts of countries worldwide, producing 3.5 billion gallons of freshwater globally every day. As populations continue to grow at rapid rates, and as the earth experiences further drought and warming, the need for more freshwater becomes ever so severe. Though it is not cheap, it is quite possibly the only way to meet the growing demand on our freshwater resources.[1]





Three technologies promise to reduce the energy requirements of desalination by up to 30 percent. The race is on to see which will take the lead.



FORWARD OSMOSIS

Water molecules migrate by natural osmosis, without energy input, into an even more concentrated "draw solution," whose special salt (green) is then evaporated away by low-grade heat.
On the market: 2010-2012

CARBON NANOTUBES

An electric charge at the nanotube mouth repels positively charged salt ions. The uncharged water molecules slip through with little friction, reducing pumping pressure.
On the market: 2013-2015

BIOMIMETICS

Water molecules pass through channels made of aquaporins, proteins that effi ciently conduct water in and out of living cells. A positive charge near each channel's center repels salt.
On the market: 2013-2015

Figure 4.1
http://www.solarserver.com/solar-magazine/solar-report/solar-report/concentrating-solar-power-csp.html

Figure 4.2

Figure 4.3
http://ngm.nationalgeographic.com/big-idea/09/desalination-pg2

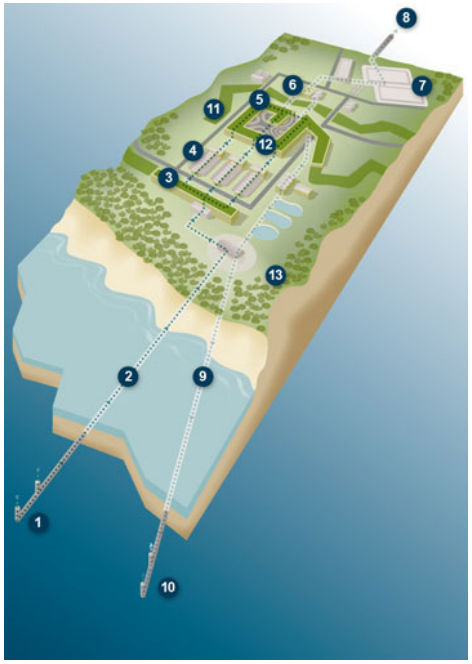
Figure 4.4
http://ngm.nationalgeographic.com/big-idea/09/desalination-pg2

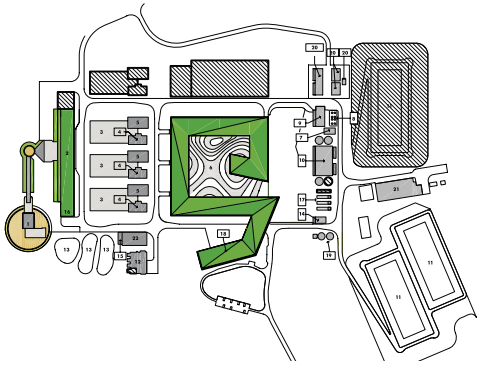
VICTORIA DESALINATION PLANT

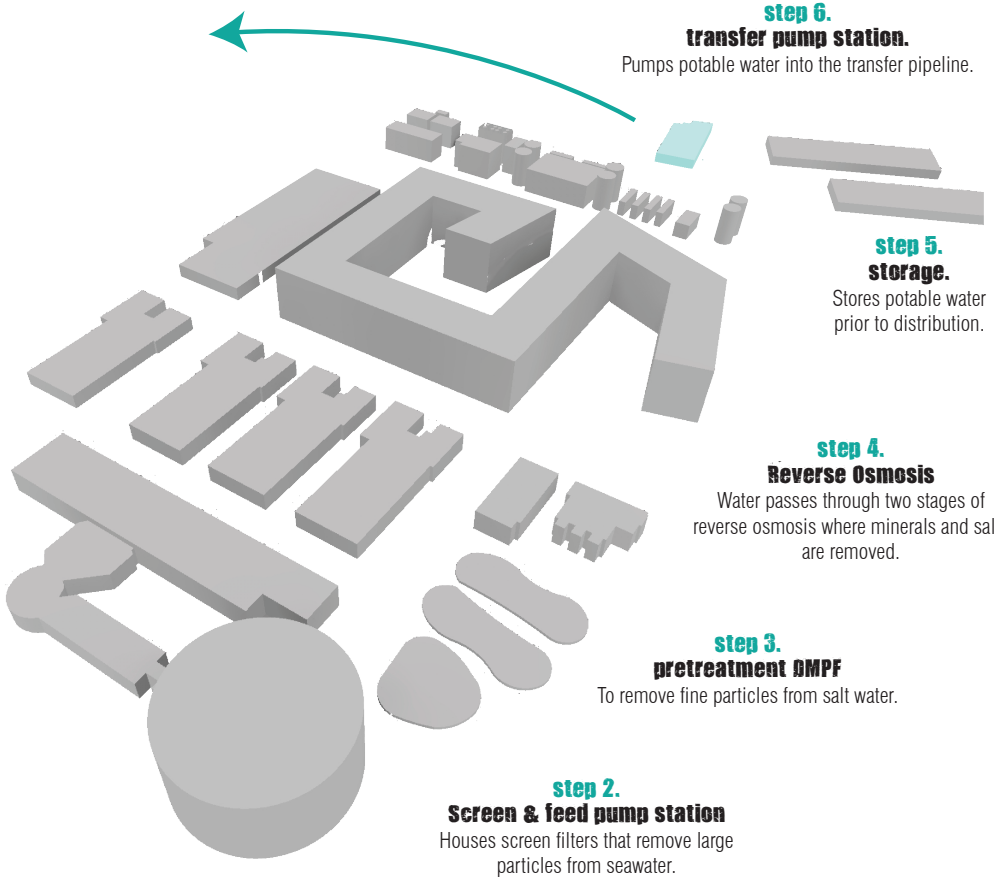
Melbourne, Australia

The Victorian Desalination Plant is the largest plant of its kind in Australia and one of the most environmentally friendly worldwide. Using state of the art technology through the process of reverse osmosis, millions of gallons of seawater are converted into millions of gallons of fresh, clean drinking water. The site, 225 hectacres once used for farming and mining, is now littered with trees and wetlands and park-scape for the public' s enjoyment. The plant and pipeline power demands will be offset in full by renewable energy sources.[2]

Cost | $23.9 billion (over 30 years)
New Pipeline | 52.2 miles
Pipe Diameter | 6 ft.
Water Product | 53.8 billion gallons per year







step 6.
transfer pump station.
Pumps potable water into the transfer pipeline.

step 5.
storage.
Stores potable water prior to distribution.

step 4.
Reverse Osmosis
Water passes through two stages of reverse osmosis where minerals and salts are removed.

step 3.
pretreatment DMPF
To remove fine particles from salt water.

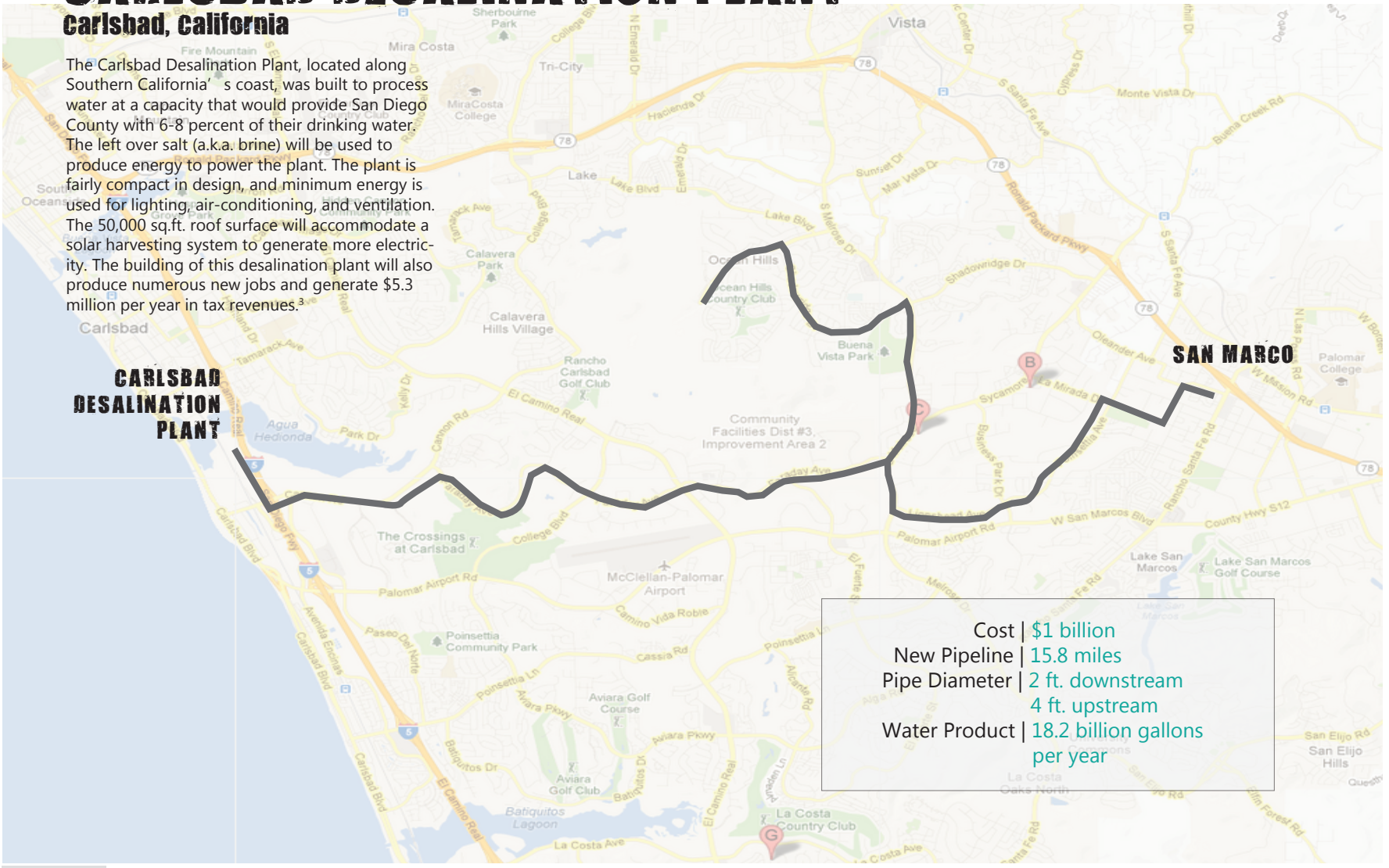
step 2.
Screen & feed pump station
Houses screen filters that remove large particles from seawater.

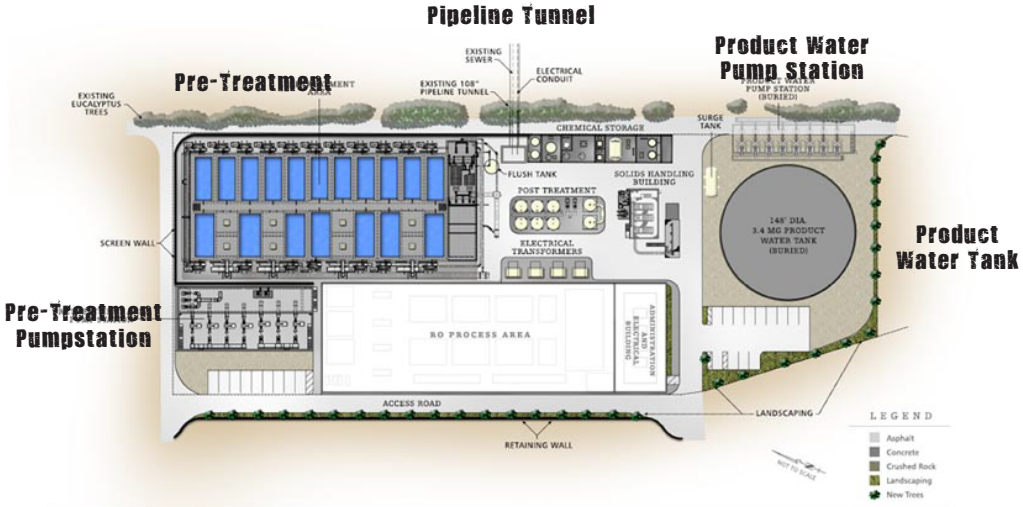
step 1.
Seawater Pump Lift
Transfers seawater to the pump station via intake structures located on the seabed.

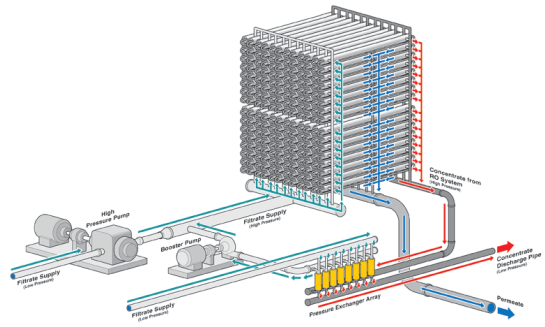
CARLSBAD DESALINATION PLANT

Carlsbad, California

The Carlsbad Desalination Plant, located along Southern California's coast, was built to process water at a capacity that would provide San Diego County with 6-8 percent of their drinking water. The left over salt (a.k.a. brine) will be used to produce energy to power the plant. The plant is fairly compact in design, and minimum energy is used for lighting, air-conditioning, and ventilation. The 50,000 sq.ft. roof surface will accommodate a solar harvesting system to generate more electricity. The building of this desalination plant will also produce numerous new jobs and generate $5.3 million per year in tax revenues.[3]



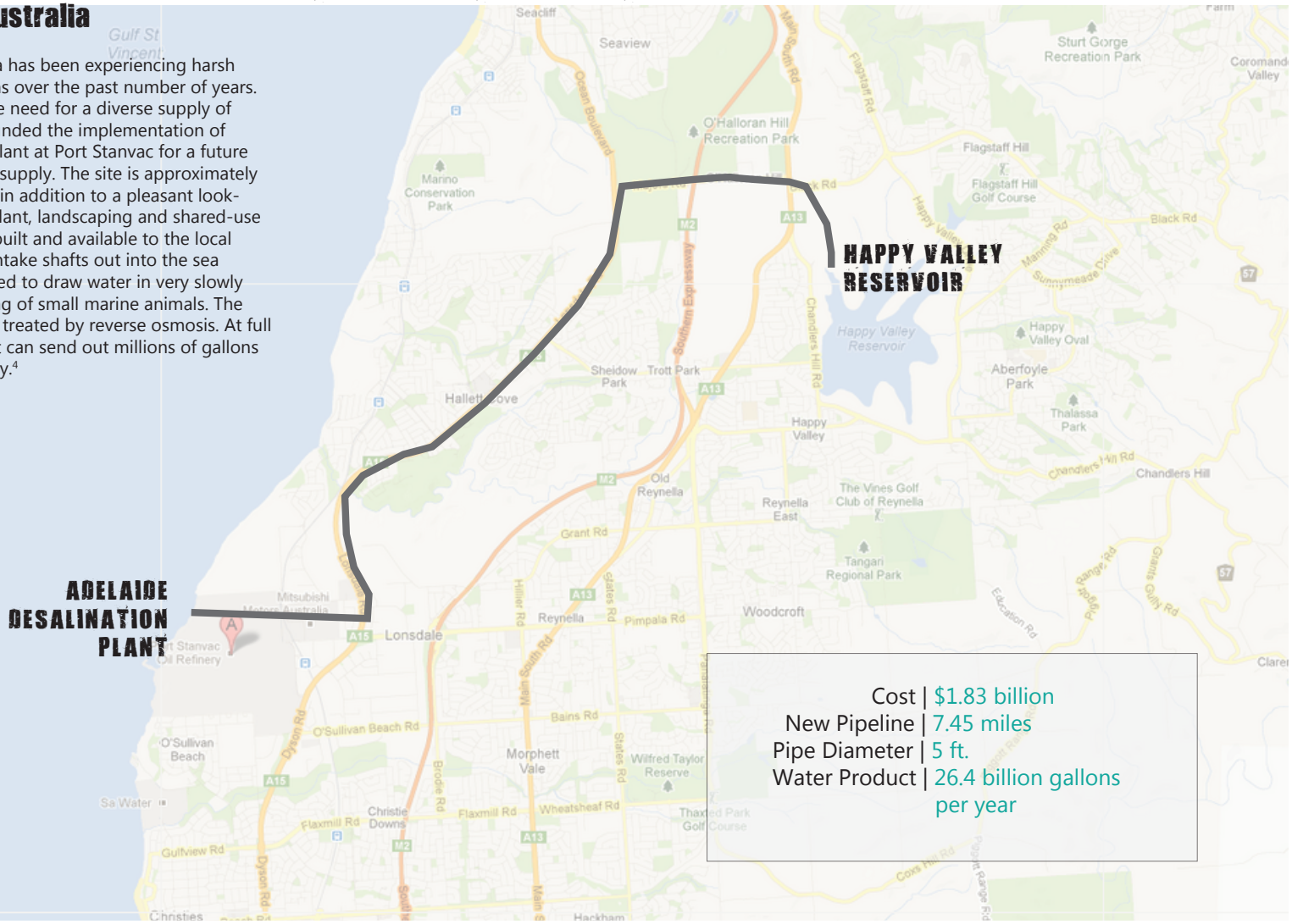

Pipeline Tunnel
Pre-Treatment
Product Water Pump Station
Product Water Tank
Pre-Treatment Pumpstation
EXISTING EUCALYPTUS TREES
EXISTING SEWER
ELECTRICAL CONDUIT
EXISTING 108" PIPELINE TUNNEL
CHEMICAL STORAGE
SURGE TANK
FLUSH TANK
SOLIDS HANDLING BUILDING
POST TREATMENT
SCREEN WALL
ELECTRICAL TRANSFORMERS
148' DIA. 3.4 MG PRODUCT WATER TANK (BURIED)
RO PROCESS AREA
ADMINISTRATION & ELECTRICAL BUILDING
ACCESS ROAD
LANDSCAPING
RETAINING WALL
LEGEND
Asphalt
Concrete
Crushed Rock
Landscaping
New Trees

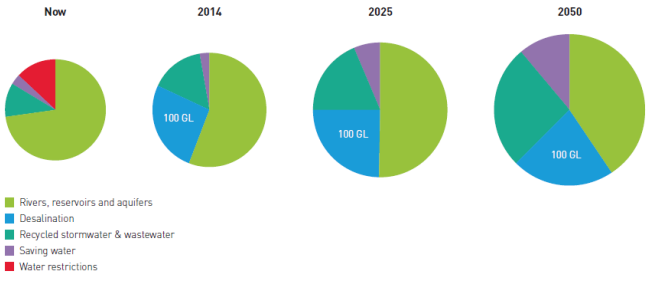

High Pressure Pump
Booster Pump
Pressure Exchanger Array
Permeate

ADELAIDE DESALINATION PLANT

Adelaide, Australia

Southern Australia has been experiencing harsh drought conditions over the past number of years. Understanding the need for a diverse supply of water, the State funded the implementation of the desalination plant at Port Stanvac for a future sustainable water supply. The site is approximately 32 hectacres, and in addition to a pleasant looking desalination plant, landscaping and shared-use pathways will be built and available to the local community. The intake shafts out into the sea have been designed to draw water in very slowly to prevent trapping of small marine animals. The water will then be treated by reverse osmosis. At full capacity, the plant can send out millions of gallons of freshwater a day.[4]





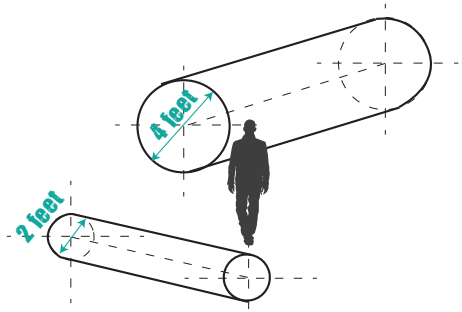
Securing water for our State

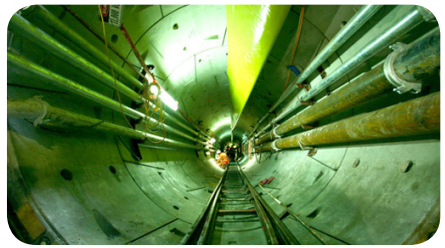
Panoramic view of the Port Stanvac site.

The New Water's Journey

Victoria Desalination

Pipeline distance =
52.2 miles





Carlsbad Desalination

Pipeline distance =
15.8 miles

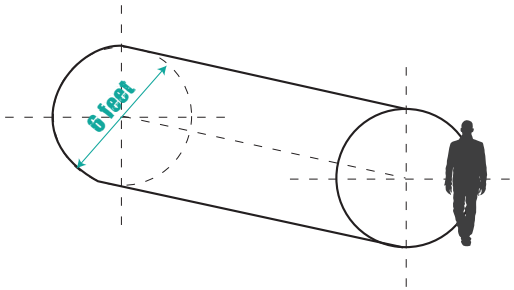
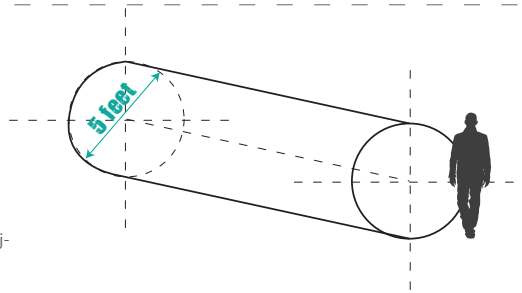


Figure 4.??

Adelaide Desalination

Pipeline distance =
7.54 miles



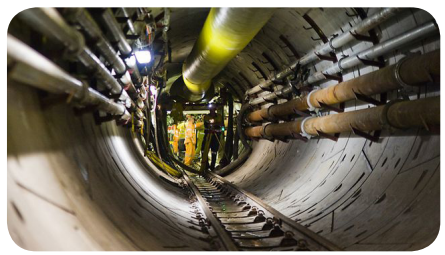
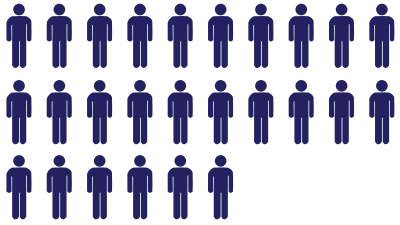


Figure 4.?
Figure 4.?? < http://www.sdcwa.org/sites/default/files/images/projects-facilities-ops/pipeline-relining/10pipe_encased_text.jpg>
Figure 4.???

Based on Las Vegas per capita consumption of water per year,
203,483 gallons,
each desalination plant can provide water for:

percentage of Las Vegas population whose water footprint would be supplied fully by the desalinated water

53.8 billion
gallons of
water
per year



264,395 people

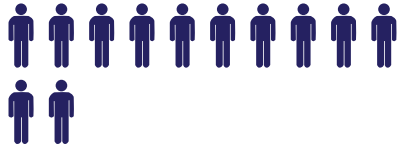
45.1%

18.2 billion
gallons of
water
per year

89,442 people

15.3%

26.4 billion
gallons of
water
per year



129,740 people

22.1%

total population of Las Vegas = 586,356
LasVegas Metro = 1,966,630

CHAPTER 5

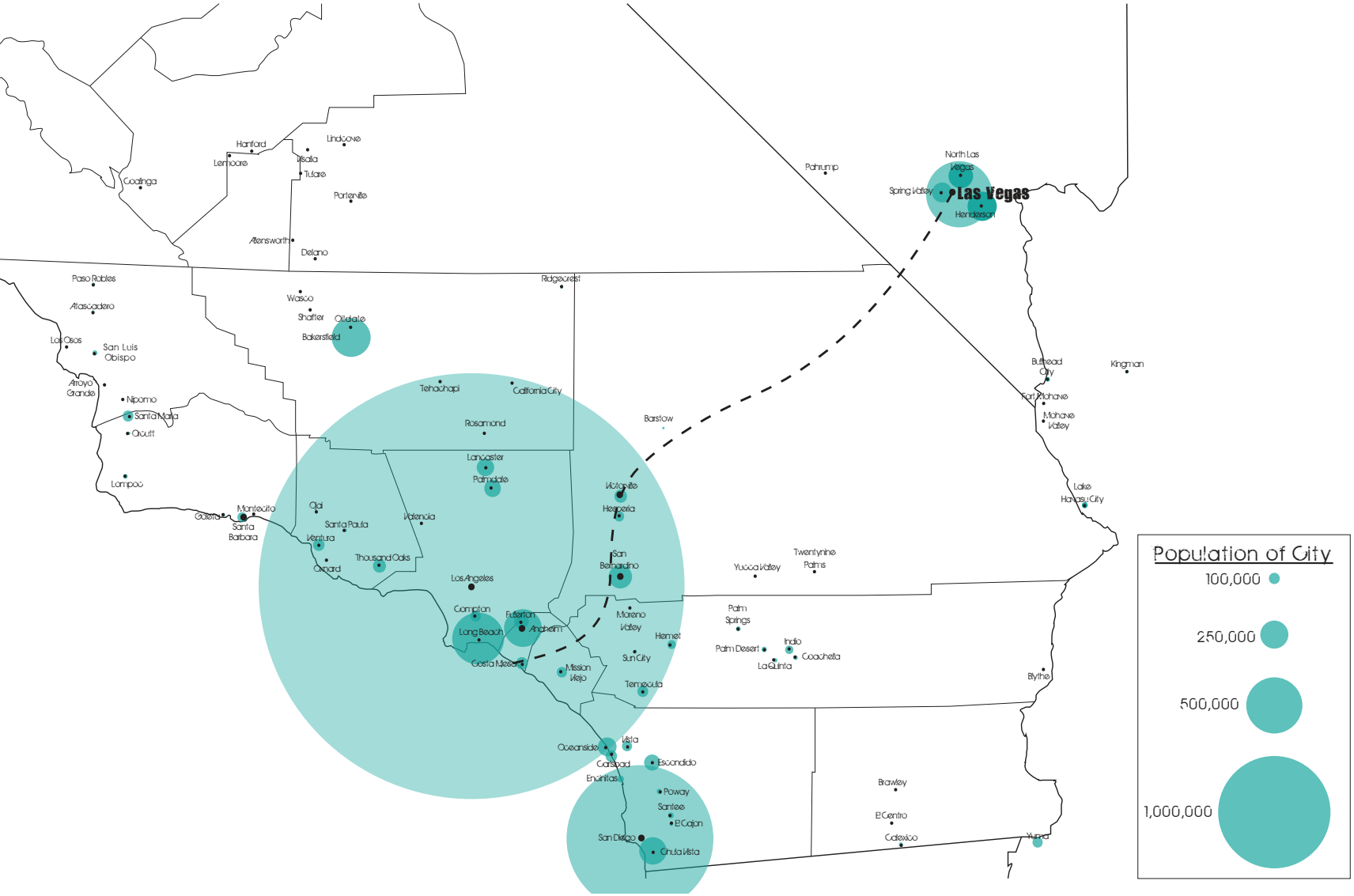
PACIFIC-VEGAS CORRIDOR

ICONS of Water Distribution

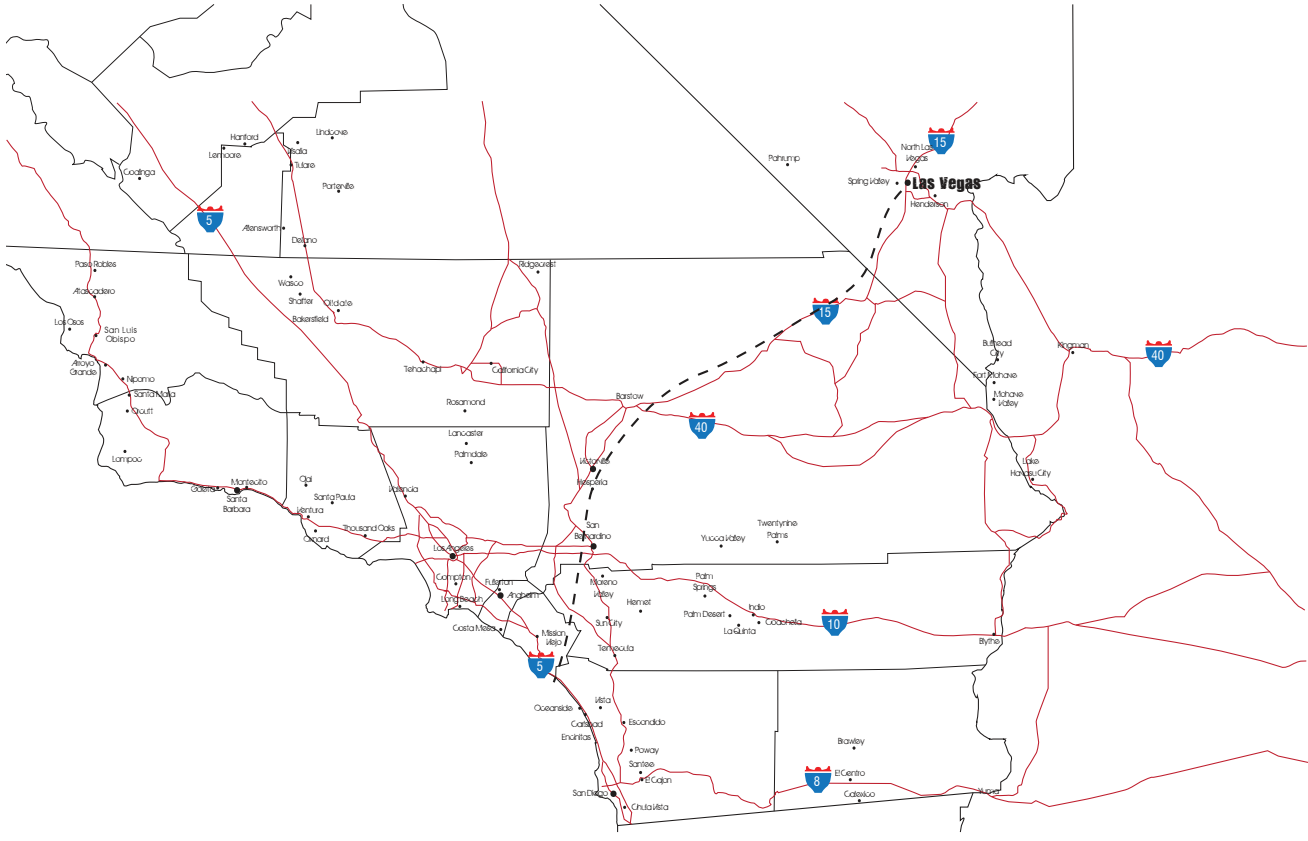
As the desalination plant outputs millions of gallons of freshwater, the matter emerges on how to get the new product to Las Vegas, some 230 miles away. The idea of transferring water hundreds of miles is an ageless one, dating back to the times of the Roman acqueducts. The desalination plant needs a new way to distribute it's product across Southern California. This water-transfer system has the potential to become extremely spatial, visual, and even iconographic.

Major Cities Along Corridor

major cities	 anaheim	 long beach	 los angeles	 san diego	 san bernardino
population	336,265	462,257	3,792,621	1,307,402	209,924
major destination spots					
major water demands					


Las Vegas
North Las Vegas
Spring Valley
Henderson
Pahrump
Hanford
Lemoore
Lindsay
Visalia
Tulare
Coalinga
Porterville
Atensworth
Delano
Paso Robles
Atascadero
Los Osos
San Luis Obispo
Arroyo Grande
Nipomo
Santa Maria
Orcutt
Lompoc
Guadalupe
Montecito
Santa Barbara
Wasco
Shafter
Oildale
Bakersfield
Ridgecrest
Tehachapi
California City
Rosamond
Barstow
Lancaster
Palmdale
Victorville
Hesperia
Ojai
Santa Paula
Valencia
Ventura
Oxnard
Thousand Oaks
San Bernardino
Los Angeles
Compton
Long Beach
Fullerton
Anaheim
Costa Mesa
Mission Viejo
Moreno Valley
Hemet
Sun City
Temecula
Yucca Valley
Twentynine Palms
Palm Springs
Palm Desert
Indio
Coachella
La Quinta
Blythe
Oceanside
Vista
Carlsbad
Escondido
Encinitas
Poway
Santee
El Cajon
San Diego
Chula Vista
Brawley
El Centro
Calexico
Yuma
Bullhead City
Kingman
Fort Mohave
Mohave Valley
Lake Havasu City
Population of City
100,000
250,000
500,000
1,000,000

HIGHWAYS


Las Vegas
North Las Vegas
Spring Valley
Henderson
Pahrump
Boulder City
Searchlight
Bullhead City
Kingman
Lake Havasu City
Mohave Valley
Fort Mohave
Barstow
Yucca Valley
Twentynine Palms
Palm Springs
Palm Desert
Indio
Coachella
La Quinta
Blythe
Brawley
El Centro
Calexico
Mexicali
Hesperia
Victorville
San Bernardino
Moreno Valley
Hemet
Sun City
Temecula
Murrieta
Mission Viejo
Lake Forest
Irvine
Costa Mesa
Huntington Beach
Fullerton
Anaheim
Compton
Los Angeles
Pasadena
Glendale
Burbank
Santa Clarita
Palmdale
Lancaster
Rosamond
Tehachapi
California City
Ridgecrest
Mojave
Inyokern
Trona
Shafter
Wasco
Oildale
Bakersfield
Delano
Porterville
Tulare
Visalia
Lindsay
Hanford
Lemoore
Coalinga
Atascadero
Paso Robles
Los Osos
San Luis Obispo
Arroyo Grande
Nipomo
Santa Maria
Guadalupe
Lompoc
Montecito
Santa Barbara
Ojai
Santa Paula
Ventura
Thousand Oaks
Oxnard
Valencia
Oceanside
Carlsbad
Encinitas
Vista
Escondido
Poway
Santee
El Cajon
San Diego
Chula Vista
Ramona
Julian
Warner Springs
Aguanga
Anza
Idyllwild
Cabazon
Banning
Beaumont
Yucaipa
Redlands
Loma Linda
Rialto
Fontana
Ontario
Chino
Pomona
Claremont
Upland
Rancho Cucamonga
Glendora
Azusa
Duarte
Monrovia
Arcadia
Alhambra
San Gabriel
Rosemead
Pico Rivera
Whittier
La Habra
Brea
Yorba Linda
Placentia
Norco
Corona
Lake Elsinore
Temecula
Murrieta
Menifee
Hemet
San Jacinto
Perris
Moreno Valley
Riverside
Jurupa Valley
Mira Loma
Eastvale
Chino Hills
Diamond Bar
Walnut
West Covina
Baldwin Park
El Monte
South El Monte
Irwindale
Duarte
Monrovia
Arcadia
Temple City
Rosemead
Pico Rivera
Whittier
La Habra
Brea
Yorba Linda
Placentia
Norco
Corona
Lake Elsinore
Menifee
Hemet
San Jacinto
Perris
Moreno Valley
Riverside
Jurupa Valley
Mira Loma
Eastvale
Chino Hills
Diamond Bar
Walnut
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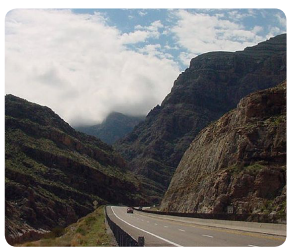
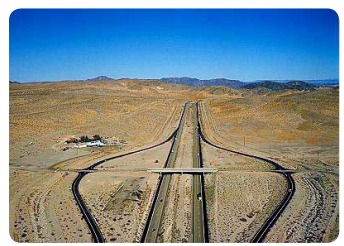
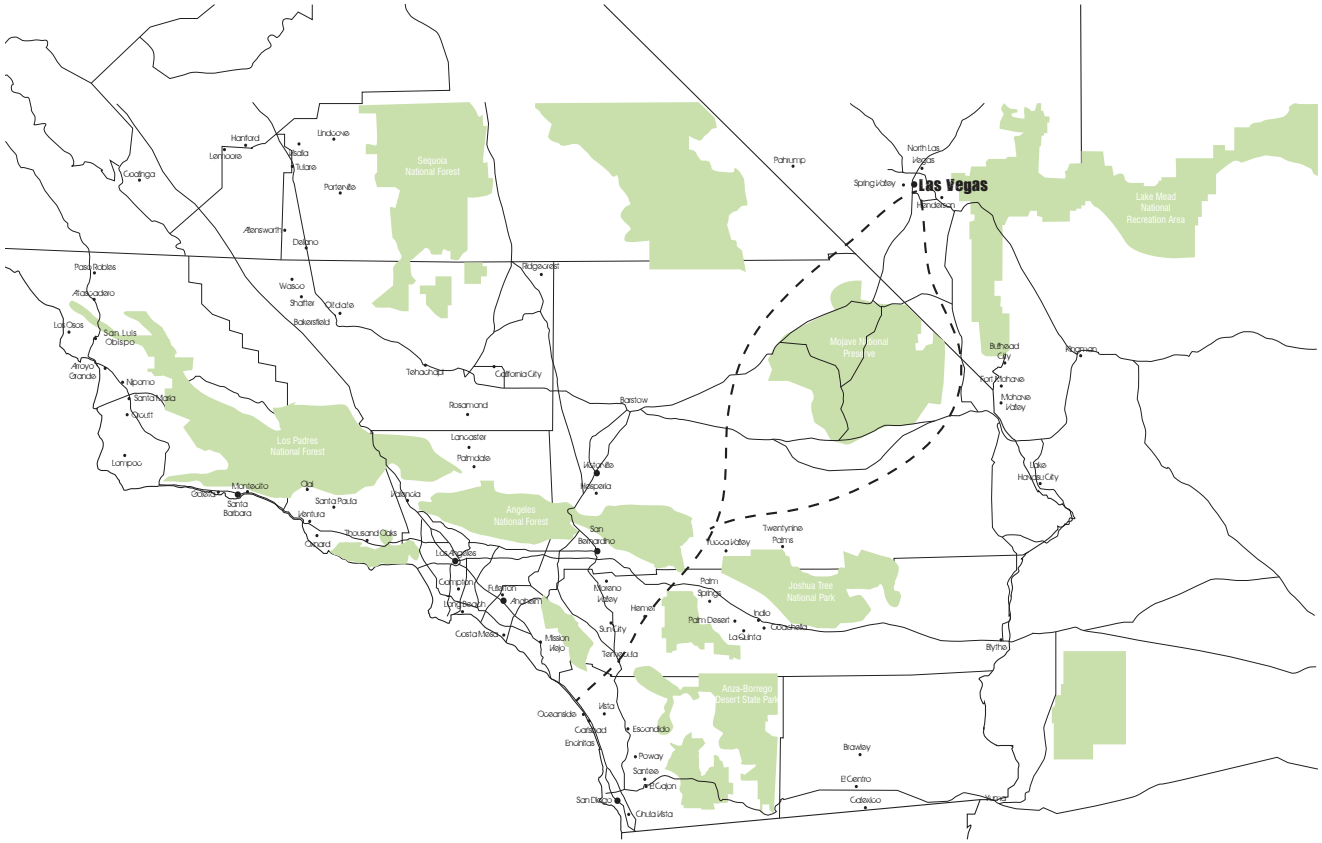
Monrovia
Arcadia
Temple City
15
40
5
10
8

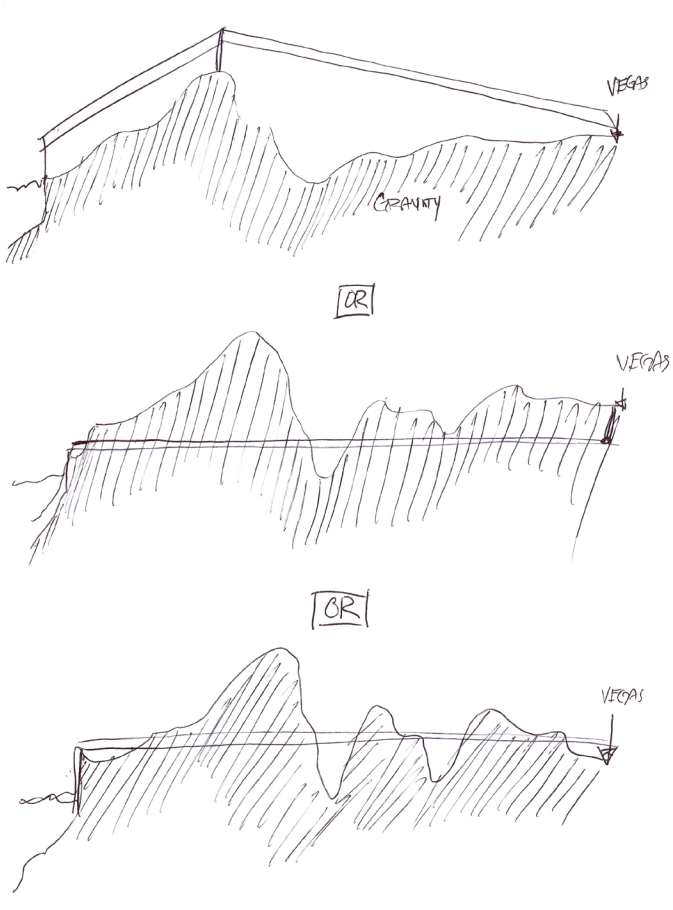


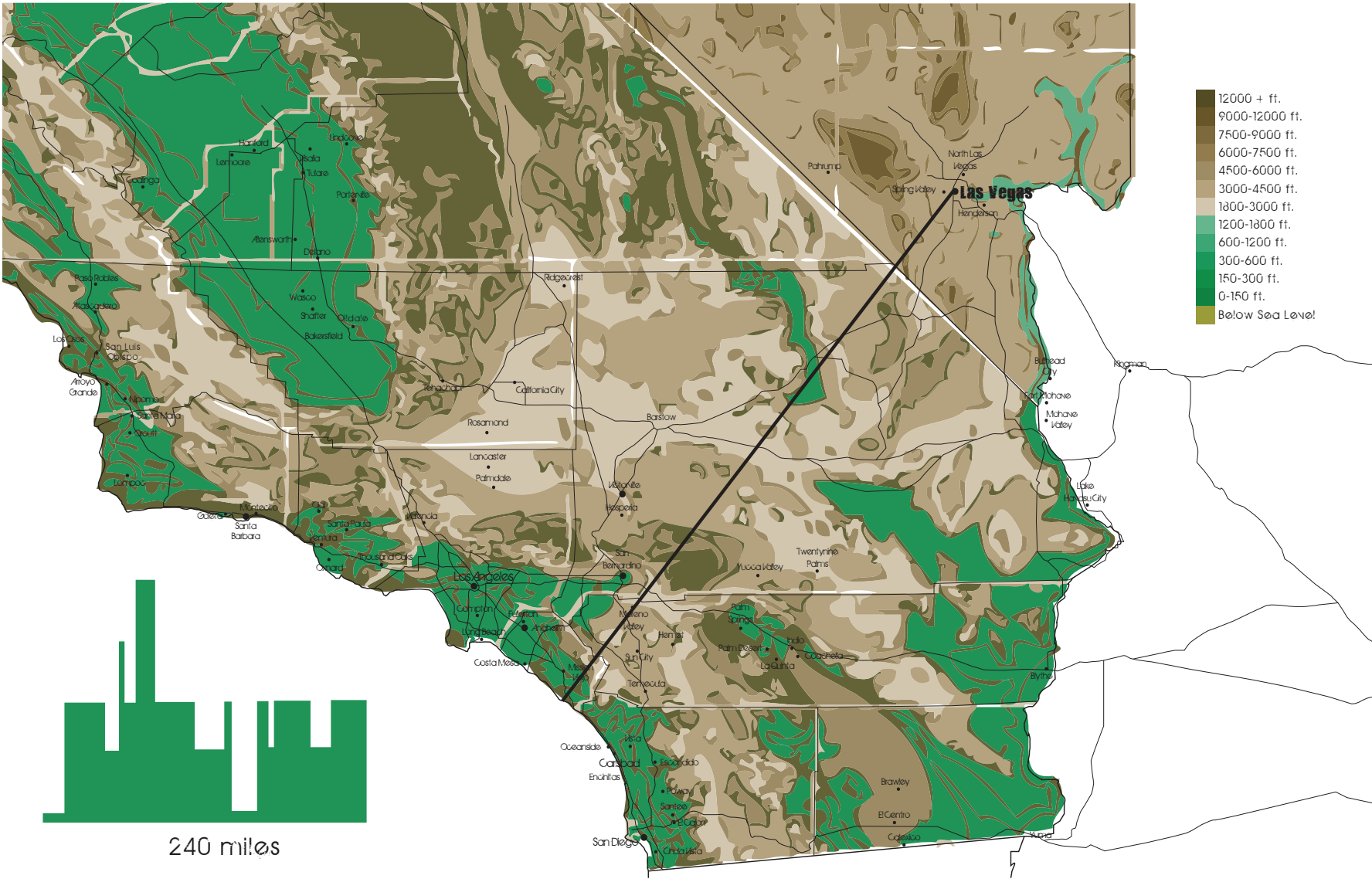


NATIONAL PARKS



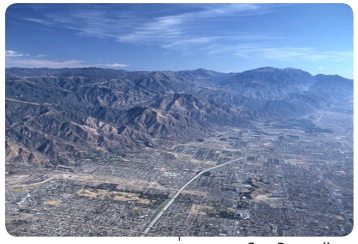
ELEVATION




12000 + ft.
9000-12000 ft.
7500-9000 ft.
6000-7500 ft.
4500-6000 ft.
3000-4500 ft.
1800-3000 ft.
1200-1800 ft.
600-1200 ft.
300-600 ft.
150-300 ft.
0-150 ft.
Below Sea Level
Las Vegas
North Las Vegas
Henderson
Pahrump
Spring Valley
Los Angeles
San Diego
240 miles

CORRIDOR PROFILE

Los Angeles

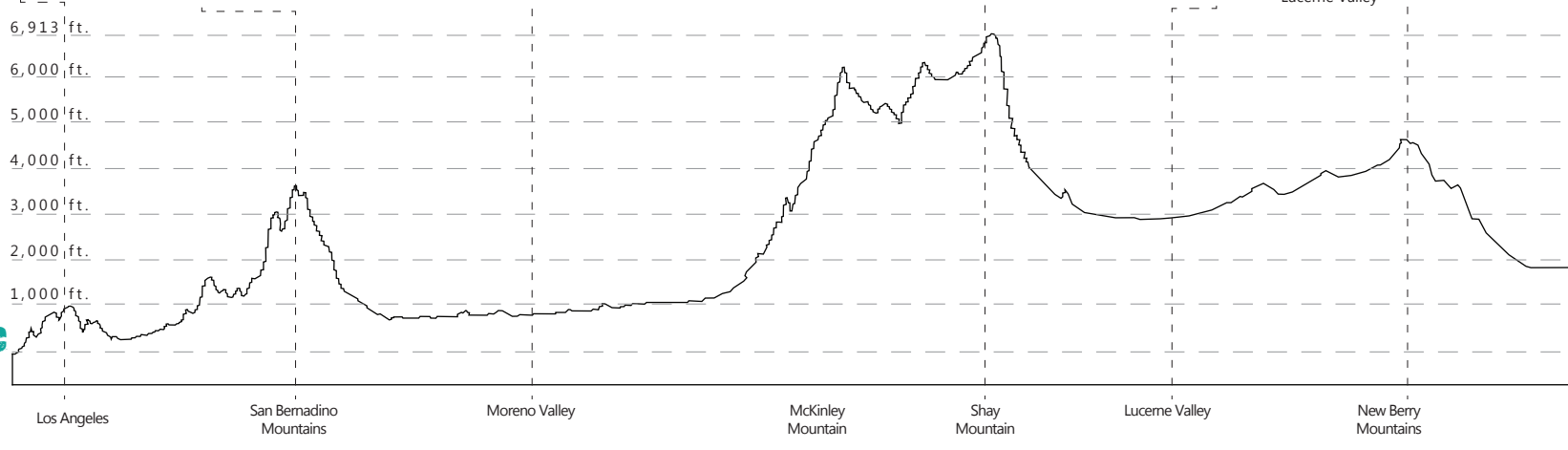


San Bernadino Mountains

Moreno Valley

Shay Mountain

Lucerne Valley



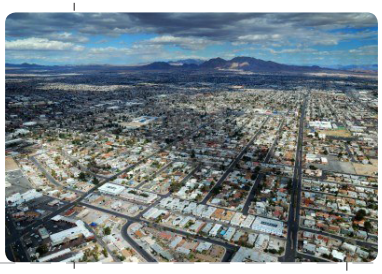
New Berry Mountains

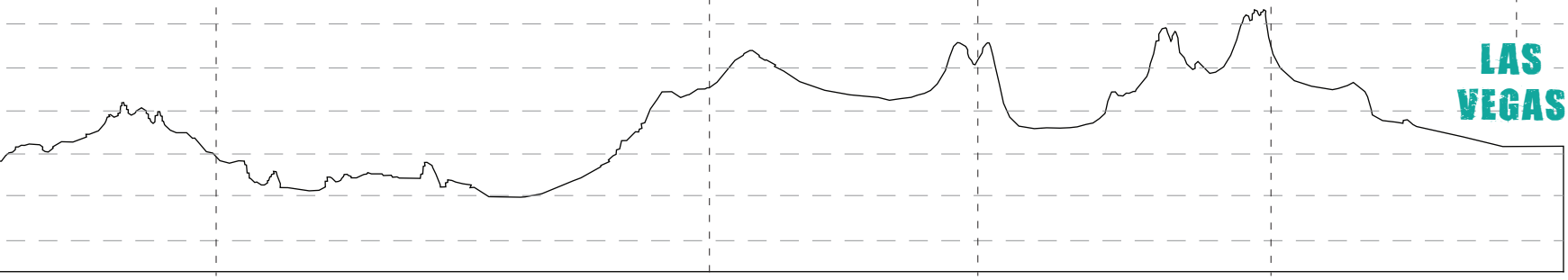
Turquoise Mountain

Bird Spring Range

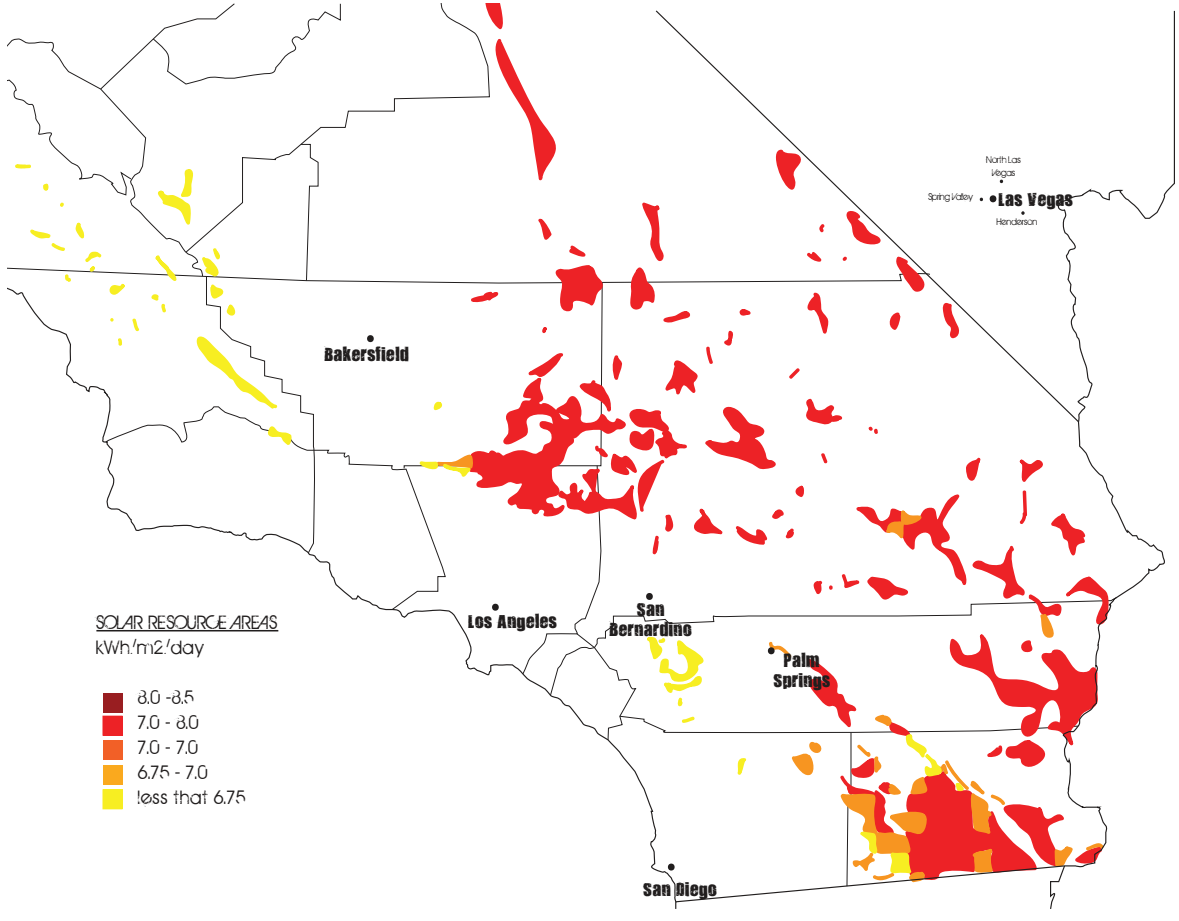
Mojave National Preserve

Mesquite Mountains

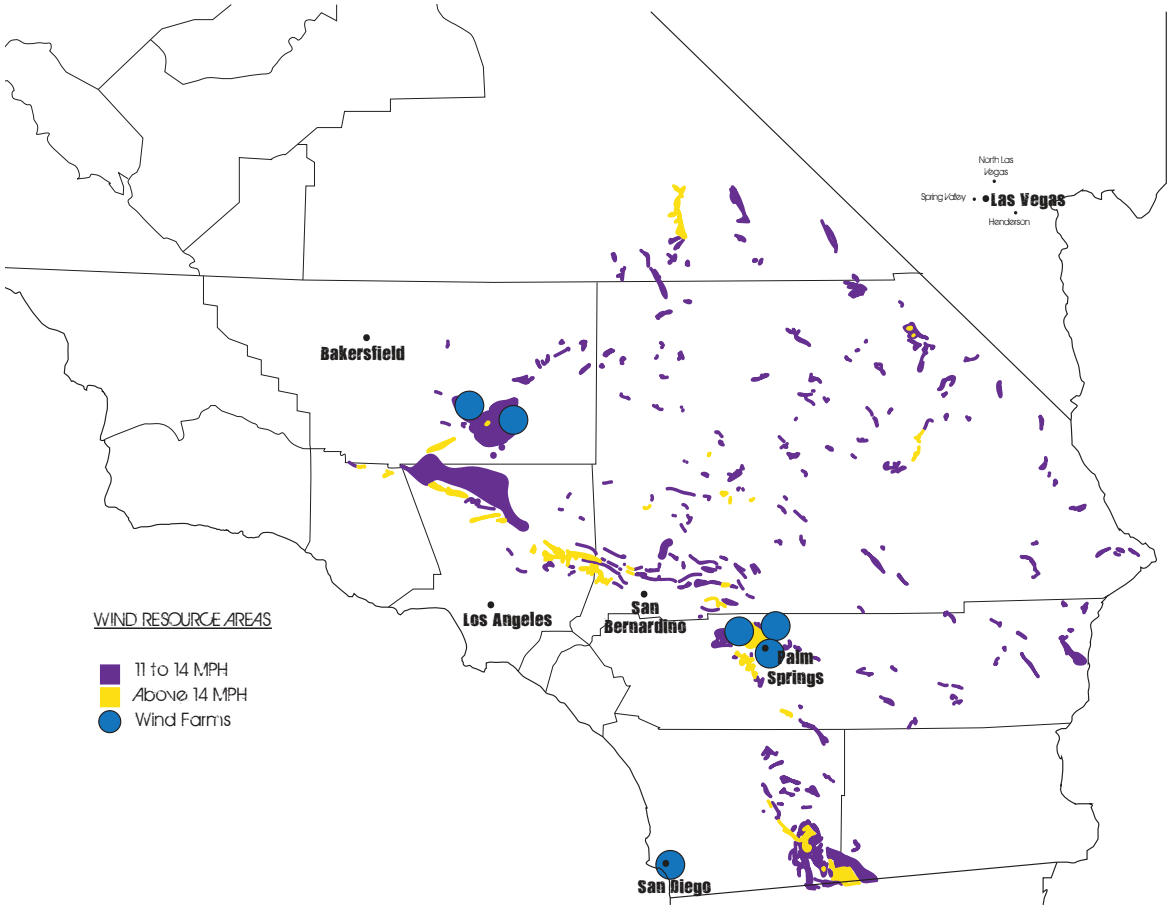




SOLAR POTENTIAL



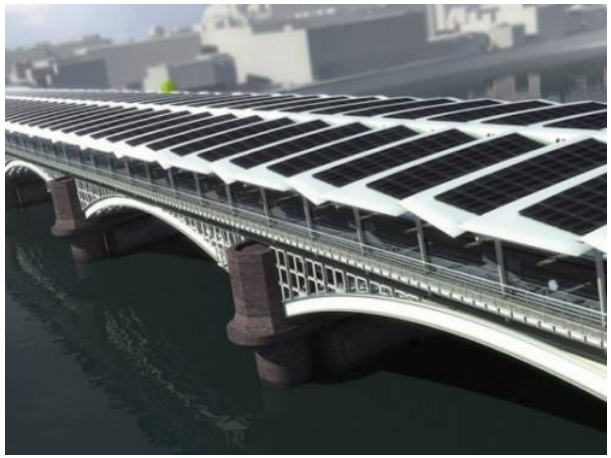
WIND POTENTIAL



MOJAVE DESERT, CALIFORNIA

OFF Architecture's "European Vertical Village"

Solar trough of Spain's Abengoa Solar



Black Friar's tube station, LONDON, UK

"Solar Arch", designed by Tyson Steele

SOLAR BRIDGES, VIADUCTS, AND INFRASTRUCTURE

KINDERDIJK, NETHERLANDS

TEHACHAPI, SOUTHERN CALIFORNIA

End Notes

[CHAPTER 1]

[CHAPTER 2]

[CHAPTER 3]

[CHAPTER 4]

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[CHAPTER 5]

(work in progress)

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Figure Credits

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